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Essays on Pricing under Uncertainty and Heterogeneity in the Finance-Trade-Growth Nexus

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Essays on Pricing under Uncertainty and Heterogeneity in the Finance-Trade-Growth Nexus

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This dissertation is dedicated to my dear parents,

Seyed Masoud Yousefi and **Maliheh Vaezian**,

who let me choose my own path;

and to my lovely wife,

Pareesa,

whom I cannot live without.

This was possible because of their love, support and encouragement.

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Essays on Pricing under Uncertainty and Heterogeneity in the Finance-Trade-Growth Nexus

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My dissertation consists of empirical and theoretical essays on Microeconomic Theory and International Economics. The first chapter discusses the existence and characterization of a model that determines producer's optimal pricing and allocation rule as a preannounced markdown schedule. The mechanism focuses on pricing and operational implications of allotting scarce resources when customers are heterogeneous in their valuations and sensitivities towards availability of product. The proposed mechanism suggests that a carefully designed multistep markdown pricing could achieve optimal revenue when selling a single unit. However, to sell multiple units, monopolist should modify the implementation of markdown pricing by either hiding the number of available products or selling them via contingent contracts and upfront payments.

In the second essay, we study the heterogeneity of finance and growth nexus across countries. Our paper contributes to the literature by investigating whether this impact differs across regions and types of economy. Using a rich dataset, cross-section and dynamic panel estimation results suggest that the beneficial effect of financial deepening on economic growth in fact displays measurable heterogeneity; it is generally smaller in oil exporting countries; in certain regions, such as the Middle East and North Africa (MENA); and in lower-income countries. Further analysis suggests that these differences might be driven by regulatory/supervisory characteristics and related to differing performance on financial access for a given level of depth.

The third chapter analyzes contraction of exports in the aftermath of severe financial crises and tests for its heterogeneity across different industries and based on their credit conditions. It provides a theoretical framework to provide insight on why sectors are hit disproportionately during and in the aftermath of severe financial distresses, and confirms most of them with empirical estimations. The findings suggest that industries with greater reliance on outside financing and fewer shares of tangible assets experience greater contractions in export volumes in the years following a severe financial crisis.

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Chapter 1

Optimal Markdown and Priority Pricing with Demand Uncertainty

Markdown and priority pricing schemes facilitate complex pricing schedules for sellers and enable strategic buyers to purchase products at desirable prices. In a preannounced markdown mechanism, the price of a product declines over time according to a specific schedule until it sells out, inducing high value customers to purchase the item earlier and at higher prices. In priority pricing scheme, each contract is assigned a ranking order and a corresponding price, according to which supply is rationed among customers. The higher customers pay, the earlier they obtain the product or the higher quality of service they receive. Research by Wilson (1989), Stokey (1979), Harris and Raviv (1981), Elmaghraby et al. (2008) and Horner and Samuelson (2011), among others investigate optimal allocation and pricing schedule, in diverse environments, varying from single unit to multiunit demand, from known to uncertain supply or demand and from complete to incomplete information environments. This paper considers an environment with uncertain demand and discusses the existence and characterization of a model that determines producer's optimal pricing and allocation rule as a preannounced and multistep markdown pricing schedule. The mechanism focuses on the operational implications of allotting scarce resources, when, at the same time, customers are heterogeneous in their valuations and in their sensitivities towards availability of the product. The proposed mechanism suggests that a carefully designed multistep markdown pricing could achieve optimal revenue when selling a single unit. However, when the monopolist has multiple units, he should modify implementation of markdown pricing by either hiding the number of available products at each stage or selling them via contingent contracts and upfront payments. Further we discuss the inefficient outcome of "commodity burning", where the monopolist may consider disposing of a portion of supply in equilibrium. And finally, we illustrate that a monopolist's optimal scheme includes offering supplementary insurance to the risk averse customers.

1.1 Introduction

Price skimming is a marketing strategy where the seller sets an initially high price for the product and lowers it over time. Thus, it enables a manufacturer, who has marketing power, to extract a greater proportion of consumer surplus. Customers with higher valuations are incentivized to purchase at earlier stages, and these higher prices insure them against the product selling out. Stokey (1979, 1988) was one of the first to use such a model to investigate the emergence of higher quality products in a learning-by-doing framework.

Recent technological improvements in electronic commerce have enabled retailers to exercise more innovative and complicated pricing schemes. One such unique format is automated and decreasing scheduled prices, called

"Automatic Markdown E-commerce". For example "Pricetack.com", an e-commerce website enables sellers to offer their products for sale using a novel falling price schedule. Manufacturers specify a schedule of falling prices with short time intervals between the markdowns. Buyers may purchase the product at the initial price or wait for more discounts and a better deal in the future. However, buyers risk losing the product to other potential customers if the item sells out before it falls to the targeted low price. Figure 1.1 provides an example, a cell-phone jammer offered with a falling price schedule, at the "Pricetack.com" website. The initial price of the product was \$320, on October 4, 2011, until when the price was marked down by \$20. The price would further drop to \$280 on October 14 and \$240 on November 3 if it did not sell out by then. The same mechanism is used widely and at a fast growing rate by other websites such as "Pricefalls.com". Figure 1.2 shows how price of an item drops according to a preannounced schedule until it sells out or the supplier ends the listing. Filene's Basement (Figure 1.3), a retailer, also employed markdown system in its Boston store until September 2007 when it underwent construction. Similarly, "Next to New," a retail store located in Austin, TX, implements markdown pricing for its products that include household furnishing items and clothing. Price items are reduced every 30 days at a preannounced rate (usually at 25%) until they sell out. Further examples have been practiced by other retailers, such as "plunging price" implemented by Sam's club referred to by Elmaghraby et al. (2008), in Dutch flower auction known as Aalsmeer flower auction (Figure 1.4), and in fashion markets.

Priority services implement a similar mechanism to discriminate between customers. Supplier provides a menu of options with different prices and service orders, where customers should pay higher for a better service ranking. Afterwards, when uncertainties are realized, supply becomes rationed according to the service ranks of the contracts. We see a strong link between these models and automated markdowns. The higher price customers pay, the earlier they obtain the product, or the higher quality of service they receive. Seminal works by Wilson (1989), Chao and Wilson (1987) and Oren, Smith and Wilson (1985) investigate markets with priority pricing schedules, such as the electricity markets. Wilson (1989) considers the effect of uncertainty in supply and excludes randomness in demand. Chao and Wilson (1987) formulate efficient rationing in the presence of demand uncertainty, while Oren, Smith and Wilson (1985) take capacity fees as a part of total tariff and illustrate how a specified capacity with known date of delivery should be priced. However, optimal pricing and rationing is still not obvious in the pricing context, especially when supply is scarce and demand is uncertain, and in the presence of customers who strategically choose the time of purchase.

Although preannounced and priority pricing schemes segment customers based on their valuations, they may lead to the "strategic waiting" phenomenon. Here, people who are willing to pay high price for a merchandise might still postpone their purchase to get the product at clearance price rather than buying the item earlier. However, if the pricing scheme can somehow create incentives for those with higher valuations so that they purchase products at higher prices, the retailer would be able to extract more from the market by performing a second degree price discrimination[1]. However, knowing customer preferences and using non-linear prices designed for different qualities of product, suppliers may capture a large proportion of the surplus by distinguishing between types of consumers.

In this paper, we study the pricing scheme in a model where demand is uncertain. We employ Mechanism Design, which is a standard tool to solve profit maximizing problems, in order to design supplier's optimal resource allocation. The goal of Mechanism Design is to achieve profit maximizing solutions where customers are incentivized to attain purchasing behaviors aligned with the objectives of the designer. For instance, Vickrey (1961) Clarke (1971) Groves (1973) mechanism, known as the VCG mechanism, designs payment schedules or money transfers in order to implement second degree price discrimination. We employ models of priority and markdown pricing schemes and explore the possibility of implementing optimal mechanism via revenue maximizing pricing schedules. In addition, we allow the seller to have commitment over pricing schedule and argue that dynamic pricing should be abandoned in such environments. The present study sheds light on the following questions by combining previous streams of the literature:

- Is it possible to obtain optimal revenue via markdown pricing scheme? How should sellers implement such mechanisms?

[1] In second degree price discrimination, sellers do not directly observe types of customers, and therefore, are not able to fully extract consumer surplus.

- Is it optimal for a seller to commit to a specific pricing path? If so, should he dispose of a fraction of the unsold products?

- How do the answers to the above questions differ when buyers are risk averse? How about the case when supplier has more than one item to sell?

Previous works have partly addressed these questions. However, a comprehensive study is missing in the literature to explain the growing and widespread use of muliple-step markdown pricing especially by online retailers. Diverse streams of past studies find it optimal to implement a sealed bid auction in the beginning period and ignore the dynamic setting. Other studies solve for the best pricing strategies when seller has no commitment over prices in the future. Therefore, it is appealing to understand how and why mechanisms with committed pricing schedules are becoming more popular. These issues together with the need for a deeper analysis of pricing multiple units have been the motivations for the present study.

Given that the strategic waiting of higher value customers is considered a loss to retailers, the literature provides operational policy advice such as suggesting suppliers offer markdowns, limited availability, advance discounts, and higher future prices, to dissuade high value customers to postpone their purchase. Su and Zhang (2008) analyze a form of retailers' price discrimination where they may inform customers that future purchasing opportunities would be unappealing. The signaling could be performed with either future high prices or limited availability. Segal (2003) considers a supplier with multiple units of a commodity who is willing to sell them through an auction to customers with single unit demand. He finds that, when valuations are private information, an optimal pricing schedule should charge the customers based on the other customers' bids. Su (2007) studies capacity rationing, Aviv and Pazgal (2008) consider preannounced pricing and committed capacity planning, and Yin et al. (2009) study a pricing mechanism and compare the profitability of two inventory display formats: display all and display one. The latter study focuses on a setting in which monopolist announces a fixed price path (a premium and end-of-period price) and manipulates customer expectations on the availability via an appropriate display format. Although the framework is very limited and allows for only two types of customers and only two price steps, the findings have intriguing operational implications and provide support for the superiority of display one over display all format. Lazear (1986) also addresses a similar question and investigates price dynamics when there are fixed number, T, of sale periods: regular and clearance prices when $T = 2$. N customers arrive in each period with homogenous but unknown to the seller valuations arrive and the seller chooses strictly falling price schedule to attain the highest possible revenue. However, this analysis ignore the fact the customers' heterogeneity except in the dimension that some customers may be serious buyers and others may be just shoppers walking around in the store. Furthermore, seller has no choice on the number of sale periods in this framework. However, it was one of the novel ideas at the time and a later study by Pashigian and Bowen (1991) investigate the Lazear (1986) model empirically. A comprehensive reference on these topics could be found in Aviv et al. (2009). Other relevant studies are Rao and Peterson (1998) and Van Mieghem (2000) who solve for the optimal pricing of priority services in a queueing context, and Anderson and Dana (2009) who state the conditions under which a supplier chooses not to offer advance buy discounts.

Other types of price discrimination could be performed by last minute and opaque selling strategies, as discussed by Jerath et al. (2009). The *Priceline.com* or *Hotwire.com* websites, for instance, offer hotel deals with approximate locations and last minute flight deals. Recent studies have also focused on the impact of the intertemporal behavior of customers on producers' profits and the mechanisms suppliers could employ for revenue management. Firms may also perform uncommon price discrimination for the purpose of profit maximization. According to Deneckere and McAfee (1996), one of the observed strategies of manufacturers has been intentional damaging a portion of their goods in order to price discriminate. Firms may intentionally produce their goods at lower qualities with almost the same marginal cost to achieve higher profits.

We build our model on the previous streams of literature who investigate price discrimination when supply is scarce relative to demand. Harris and Raviv (1981) focus on an environment with uncertain demand and show that when supply is abundant, fixed pricing is optimal. In the case of scarce supply, they illustrate how a Vickery mechanism should be used by a producer. Another study by Liu and Van-Ryzin (2008) points out that in the case of preannounced prices, optimal strategy for a monopolist could be to deliberately understock a product and cause shortage in order to create incentive for higher value customers to buy the product earlier and at higher prices. Elmaghraby et al. (2008) extend those findings to the optimal mechanisms in the presence of multiunit demand under both complete and incomplete information. They find that under known demand structure and scarce supply, a two step markdown schedule is optimal. Moreover, they show that under certain conditions, private and incomplete information, three step markdowns might be implemented by a monopolist. However, they claim that seller will never find it optimal to employ more than three steps. The recent paper by Osadchiy and Vulcano (2010) build on Elmaghraby et al. (2008) and argue that when customers are heterogeneous in their valuations and arrival time, a binding reservations mechanism could be superior to markdown pricing when it is costly for customers to wait for the product. However, they compare their model with a simple two step markdown pricing and there is no uncertainty in the demand structure. In a related study, Krishna (2002) provides optimal auctions and revenue equivalence between different sets of prices in a multiperiod setup. Customers are independently and identically drawn from a known distribution in his framework. He shows that multiple unit auctions share two common features: revenue equivalence and prices following a martingale process, i.e., prices in the following period are expected to be the same as the current price and knowledge of past prices will never help predict future price levels.

The last set of relevant research include the work by McAfee and Vincent (1997), Skreta (2006), Horner and Samuelson (2011), and McAfee and Vincent (1993) who solve the pricing problem of a monopolist unable of committing to future prices. Skreta (2006) shows that a seller with full bargaining power may post prices in each period. She makes a prominent contribution to the dynamic pricing schemes since other studies' methodologies do not apply to the frameworks in which seller behaves sequentially. The reason is that the revelation principle is invalid in such cases and it makes the analysis too complicated to solve for an equilibrium without applying the principle. McAfee and Vincent (1997) investigate a closely related problem where the seller chooses a sequentially rational mechanism against finitely many buyers. They find that the seller implements a sequence of first price or second price auctions. Time horizon is infinite, and therefore, seller lacks the ability to effectively enforce a reserve price. In another relevant study by Horner and Samuelson (2011) seller sets prices in discrete steps to finite number of customers. Because of the existence of a deadline to sell the items, seller benefits from having some bargaining power, and therefore, the outcome differs from that by Coase (1972), known as the Coase conjecture. Under certain conditions, the conjecture shows that a monopolist will compete with itself over different periods of sales and could not earn positive profit. The reason is simply because the retailer has no commitment over future prices. In addition, the research by McAfee and Vincent (1993), studies the declining price auctions of identical items that are sold sequentially. They find that it is necessary to assume non decreasing absolute risk aversion for the existence of pure strategy equilibrium bidding functions in a falling price setting. Otherwise, outcomes may be inefficient with positive probability. The study differs from others in that we focus on the optimality of declining prices (maximum revenue to seller) while they question the efficiency of mechanism (maximum social welfare).

This paper considers the environments where there is uncertainty in demand and formulates the optimal pricing schemes for a monopolist. It shows that uncertainty enables producer to further squeeze customers by performing greater number of markdowns. Therefore, the current study adds to the three streams of literature and characterizes optimal pricing schemes when seller has commitment power against finite number of customers. Firstly, absent risk aversion and income effects, we demonstrate that when demand is uncertain, multistep markdown pricing is optimal for a service provider, and it is superior to the frequently used two step markdowns. We further study the case of customers with multiple units of demand and find that offering contingent contracts is optimal for the retailer and superior to the implementation of markdown schemes. Therefore, the retailer can attain higher profits from the market by enforcing contingent contracts rather than employing a preannounced pricing scheme. Moreover, we study the case of risk averse customers and find that offering insurance options to customers is optimal for the retailer and also pareto improving. In other words, when customers are sensitive to the quality of service or availability of product, monopolist and customers all benefit from having the retailer, or a third party, supplement contracts with insurance. Therefore, retailer can attain higher profits from market by enforcing a preannounced pricing scheme with upfront payments and insurance options, and customers will be better off hedging themselves against risks of service disruption or unavailability of desired product. Table 1.1 provides a summary of related research in pricing against strategic customers compared with our study.

In addition, we illustrate how markdown or priority pricing schedules generate inefficiencies. We argue that a retailer may intentionally dispose of a portion of its products rather than putting them up for sale. In other words, decision of a supplier shall include “commodity burning” if the realized demand for higher prices falls below a particular limit. The purpose is to discourage higher value customers to wait until the last minute for clearance sales or further discounts. Thus, although the decision to throw away a fraction of products is inefficient in a social-welfare maximization point of view, it should be used by retailers to prevent the strategic waiting phenomenon in order to increase profits.

Our mechanism is a type of second degree price discrimination. It is different from first degree price discrimination and the seller can not extract the whole surplus since he does not know the valuations of customers. The equilibrium prices show that each customer (except the lowest type who pays his/her own valuation) pays lower than his/her valuation. The differential amount - the difference between valuation and payment - is called ”rent” and it increases as type increases, i.e., higher types receive higher rents. The reason is that high value customers have private information and the mechanism should give them greater rent to provide incentive for them to reveal true valuations.

The organization of this paper is as follows: Section 1.2 provides a model based on priority services and markdown pricing in the presence of uncertain demand for a single unit of product. It characterizes the revenue maximizing allocation and pricing scheme, and pursues with the case where the seller has multiple units to sell. Section 1.3 discusses the optimal allocation to risk averse customers and characterizes an equilibrium with upfront payments and insurance schemes. Finally, Section 1.4 concludes, provides operational management implications and outlines questions and future lines of research.

1.2 Model

We find it a reasonable assumption to consider commitment to a specific pricing path for retailers with multiple number of products who consider profitability of future sales as well. One should note that some retailers commit to a specific announcement and stick to it even if it turns out not to be optimal. Retailers such as "pricefalls.com" may find it profitable to change the price path of an item after they observe its sale at an initial price, but they may also find it too costly to do so. Similar websites who run parallel auctions and proactively seek more products to sell on their website, will threaten the credibility of pricing schedules for their other products if they forgo the predetermined pricing and start selling in a sequentially rational way. Furthermore, pricing with no commitment has other significant disadvantage for sellers. As Coase (1972) argues, when a seller has no commitment power, multistep pricing leads to zero profit - due to the strategic behavior of the customers and that the seller competes with himself over different periods.

The theoretical model consists of a profit maximizing monopolist who provides a product with a corresponding price schedule. On the other side, each customer maximizes her expected utility given available options. All future prices are determined at an initial date and before the realization of uncertainties. We show that a retailer benefits from the uncertain world and extracts more from customers by exercising priority or markdown schemes. In this section, we start with a model where the monopolist has a single item for sale and solve for optimal mechanisms including preannounced markdowns and priority pricing. We postpone the discussion of multiunit sale until Section 1.2.2 where the supplier has a fixed and commonly known stock of product. We formulate the solution and provide the optimal pricing schedule in both single unit and multiunit cases. Furthermore, we compare priority pricing with preannounced markdowns and argue that it is not optimal to sell sequentially when multiple units are for sale.

The monopolist is risk neutral and has a commonly known fixed supply, S, which is equal to one unit in this Section. The seller has already paid all the costs to produce, i.e., sunk costs, and we assume there are no expenses regarding storage. Also, the object has no value for the seller if unsold and may be disposed of at the end of the sales season. On the other side, customers are heterogeneous in their valuations for the product. For instance, a celebrity might value a fashion clothing more than others, or as another example, an automobile manufacturing company might value the quality of electricity, in terms of lower rate of interruptions, more than a residential consumer[2]. Furthermore, we assume that the prices are announced before the demand is realized. Customers' valuations are private information and therefore, unobservable to others in the market. There are finite, M, with valuations $\{v_1, v_2, ..., v_M\}$ drawn independently from an identical distribution with cumulative density function $F(.)$ (where $f(.)$ denotes the probability density function)[3].

Furthermore, possible valuations are equally distanced from each other over the normalized interval between zero and one, i.e., $\{\theta_1 = \frac{1}{N}, \theta_2 = \frac{2}{N}, ..., \theta_N = \frac{N}{N}\}$. For simplicity, we consider a distribution where each possible valuation is equally likely to occur with probability $\frac{1}{N}$.

Conditional on consuming the product, expected utility of a consumer with valuation v_i is represented by:

$$U(v_i, p) = u(v_i - p),$$

where p denotes the price and u(.) is the utility function. The utility function

[2]Nuclear plants, for instance, are highly sensitive not only to electricity blackouts but also towards power sags, or undervoltage even for up to a few seconds.

[3]In reality, only some of the whole population are aware of, for example, pricetack.com and check their website. A seller should implement markdown pricing to target this group. However, it does not mean that people who are not aware of the website do not need the product or are casual buyers. It just means that seller need not worry about them and he should have a good approximation of the distribution of the people who are checking his website. It is therefore crucial that seller considers the distribution of his audience rather than the total population, if different.

is assumed to be linear in our framework until section 1.3 where we address the case with risk averse customers. One way of selling the product is the fixed price scheme. In a fixed price sale, seller posts a price p and customers whose valuations are greater than the price, if there is any, purchase the product. However, there is a better alternative for the seller in which he considers uncertainties in demand and decides to take that in account together with an effort to discriminate between different types of customers for a higher expected revenue. But how should he define the price path? and is it the best possible scheme, in terms of expected revenue, to sell the item via markdowns?

One could consider three methods of price discrimination between different types of customers. One method is to implement a falling price schedule as performed by “Pricefalls.com” and “Pricetack.com”. These websites announce a future price path for each product with exact markdowns. On the demand side, people observe the price schedule and pick up the stage to step in and purchase the product. As illustrated by Figure 1.1, the retailer has specified five markdowns to sell a cell phone jammer at the Pricetack.com website. Customers pick their favorite price and wait for the time when the price drops to that specific level. A strategic buyer may wait for lower prices, but she also faces the risk of unavailability if she decides to postpone her purchase. The second method to sell the product, as described by Horner and Samuelson (2011), is to implement sequentially rational sales in which price is update in every single period in a dynamic environment. Therefore, the seller will have no commitment on the plunging prices and one may even observe a jump in prices since no announcements for future prices are credible. Finally, we consider the option that the seller implements a sealed bid auction in the first period. Customers announce their bids via sealed envelopes, or with providing their credit card number, and the seller allocates the product to the highest bids with prices determined by the mechanism. As we will discuss, the latter mechanism achieves optimal profit, the maximum surplus a seller could extract via a pricing scheme, but it suffers from being too complicated to practice everywhere. One restriction to implement such a mechanism is to have all customers bid at the beginning of the sale and the seller allocate the good in a static framework. However, customers are usually more convenient with observing dynamic prices with gradual changes rather than deciding about their desirable bid in a complicated mechanism. Furthermore, a retailer may be able to attract more customers, especially those not educated, with simpler and easier to understand pricing methods. To summarize, we compare the following three mechanisms and discuss managerial implications and optimality of each scheme (discussion of the C scheme is available Section 1.3):

A) A menu of priority services (static solution)

B) Dynamic pricing with a preannounced and committed path

C) Priority pricing with upfront payments and supplementary insurance

One should note that people are served according to a priority allocation rule in model A. Supplier implements a mechanism by allowing customers to choose among a set of priority orders, $r \in [r_T = (N - T + 1), ..., r_{N-1} = 2, r_N = 1]$, where $1 \leq T \leq N$. The first or top ranking order, $r = 1$ or $r = r_N$, is served first with the highest probability of receiving the product, and the lowest ranking order, $r = N - T + 1$ or $r = r_T$, is served last with the least probability. Each priority level is paired with a corresponding price and the menu of contracts is denoted by $< r, p(r) >$. Monopolist offers different choices to discriminate between different types of customers, and since there are N types in the market, maximum number of choices in the menu should be N which occurs when $T = 1$, i.e., offering more options than the number of types is redundant. The second plan, B, is similar to the priority pricing A in the way that it contains a set of prices implemented as markdown pricing. Rather than offering a menu of prices and ranking orders, the seller may start with an initial price p_N, lower it to p_{N-1} in the second period and continue decreasing prices on a preannounced path until price reaches p_T in period $N - T + 1$. However, the difference with plan A is in that the sale is not implemented in a single period. It starts with an initial high price, continues plunging according to a committed schedule and terminates either at price p_T or when the item sells out before price reaches that floor level. We will show that both plans, A and B, are equivalent and both are optimal when there is a single unit for sale. However, their difference is significant when there are multiple units for sale (discussed in Section 1.2.2). Our "Prictack.com" example, Figure 1.1, is a perfect example for plan B. The retailer has specified five markdowns to sell a cell phone jammer. People observe the price path and make their mind about when to step in and purchase the product. Finally, plan C implements a mechanism similar to plan A with the difference that the seller offers supplementary insurance with the menu of priority options. The seller bears more risk and pays all or a portion of customer's money back if she is not served after the winning merchants receive their products.

1.2.1 Optimal Pricing

Thus far, the monopolist's problem to solve for a mechanism with maximum revenue seems very complicated. Customers are strategic and there are too many ways to implement price discrimination. However, the complication could be simplified by employing the revelation principle:

Theorem 1.2.1. *Revelation Principle*[4]*: for any scheme in our incomplete information game, there exists a payoff equivalent scheme with an equilibrium which is both direct and truthtelling, i.e., players report their types truthfully.*

Using the revelation principle, we can limit our search to the set of mechanisms in which customers report their types truthfully. Therefore, we consider cases in which customer i has a valuation $v_i \in \{\theta_1 = \frac{1}{N}, \theta_2 = \frac{2}{N}, ..., \theta_N = \frac{N}{N}\}$, and given truthfullness of other customer, she should not have incentive to report any valuation except the true one, i.e., $\hat{v}_i = v_i$.

Since there are N possible valuations for each customer, when a representative customer i reports the highest valuation $\hat{v}_i = \theta_N$, it is as if he

[4] A proof of the theorem can be found in Myerson (1979).

has chosen number 1 in the ranking among all possible ranking orders, i.e., $r(\theta_N) = 1$. Similarly if someone declares $\hat{v}_i = \theta_{N-1}$, it is as if he has chosen ranking number 2, i.e., $r(\theta_{N-1}) = 2$, and the person who announces that his type is the lowest, $\hat{v}_i = \theta_1$, means that his rank is N among the customers, i.e., $r(\theta_1) = N$. Therefore, from now on, we assume that each person i with valuation v_i declares his type by choosing a ranking order, $\hat{r}_i$. The choice will be truthtelling in the new messaging space if $\hat{r}_i = r(v_i) \in \{1, 2, ..., N\}$, where $r(.)$ is the function defined above, which maps valuations to the ranking orders. The function is one to one and strictly decreasing, i.e., the higher the valuation, the lower the ranking order. This function allows us to use the nice intuitive features of pricing based on ranking orders while at the same time, it keeps the mechanism direct, i.e., as if customers message their types directly. For simplicity purposes we denote $r(\theta_l)$ with r_l, $\forall l \in \{1, ..., N\}$.

We denote the allocation rule for customer i, in an optimal mechanism, by $g_i(\hat{r}_i, \hat{r}_{-i})$, which is a function of her choice, $\hat{r}_i$, and the choices of all other people in the market, $\hat{r}_{-i}$ (which is a vector that contains ranking orders chosen by all people other than customer i). A customer who chooses the rank $\hat{r}_i$, will be served according to the allocation rule $g_i(\hat{r}_i, \hat{r}_{-i})$ and should transfer $t_i(\hat{r}_i, \hat{r}_{-i})$ which depends on the declarations of all customers. Therefore, given report $\hat{r} = (\hat{r}_1, ..., \hat{r}_M)$ by all customers, seller allocates supply to them according to the allocation rule $g(\hat{r}) = [g_1(\hat{r}), ..., g_M(\hat{r})]$, and transfer rule $t(\hat{r}) = [t_1(\hat{r}), ..., t_M(\hat{r})]$.

According to the revelation principle, we are interested in the truthtelling schemes in which players report their rankings according to their true types, $\hat{r}_i = r(v_i)$. Therefore, we denote truthtelling reports by r and distinguish any other report by $\hat{r}$ for clarity purposes. Therefore, assuming that all other players are ranked truthfully, individual i takes expectation over other consumers' choices, r_{-i}, and obtains expected probability of receiving the product, $q_i(\hat{r}_i)$, and expected payment, $p_i(\hat{r}_i)$, for service order $\hat{r}_i$ as:

$$q_i(\hat{r}_i) = E_{-i}[g_i(\hat{r}_i, r_{-i})], \tag{1.1}$$

$$p_i(\hat{r}_i) = E_{-i}[t_i(\hat{r}_i, r_{-i})], \tag{1.2}$$

where E_{-i} denotes expectation taken over all possible states of demand for all customers except i, given that everybody else is truthful.

If customer i with valuation v_i is willing to participate in the game, she will expect to receive the product with probability $q_i(\hat{r}_i)$ at the expected price $p_i(\hat{r}_i)$ if she chooses the ranking order $\hat{r}_i$. If she decides to take the contract with ranking order $\hat{r}_i$, her expected utility will be:

$$U_i(\hat{r}_i; v_i) = E_{-i}[u(g_i(\hat{r}_i, r_{-i})v_i - t_i(\hat{r}_i, r_{-i}))], \tag{1.3}$$

which will reduce to the following expression if customers are represented by quasilinear utility functions:

$$U_i(\hat{r}_i; v_i) = E_{-i}[g_i(\hat{r}_i, r_{-i})v_i - t_i(\hat{r}_i, r_{-i})] = q_i(\hat{r}_i)v_i - p_i(\hat{r}_i). \tag{1.4}$$

Therefore, due to the incomplete information environment, customers face an allocation rule with corresponding prices, and report their ranking orders (or their valuations, equivalently) based on their privately known information. We assume that if a customer decides to stay out of market, she will gain zero utility. Therefore, we normalize outside option's utility to zero, and interpret it as not taking any contract. Therefore, we can formulate the customer's maximization problem as:

$$max\{0, max_{\hat{r}_i}\{U_i(\hat{r}_i; v_i)\}\}. \tag{1.5}$$

We can see that the expected utility function, if non-zero, satisfies the condition that agents' marginal rate of substitution is increasing in type, i.e. $\frac{\partial}{\partial v}(\frac{\partial U_i(.)}{\partial q}) > 0$. In short, the assumption is a sufficiency condition to insure that any monotonic allocation $q(.)$ is implementable. Therefore, the designer can search over the monotonic allocation mechanisms for an optimal solution. This mechanism should offer a better deal to higher value agents. Otherwise, in any mechanism that higher types face punishment for reporting true values, they have incentives to misreport themselves as lower types.

The timing is as follows: First, supplier designs a mechanism to maximize his profit from allocating supply to the heterogenous customers. For any set of choices by the customers (ranking order r, or equivalently, valuations), a contract specifies payments for the bidders. Then, customers choose their ranking order from the seller's menu. And finally, seller serves customers and charges them according to the allocation rule.

The monopolist designs a mechanism to incentivize higher value customers to purchase earlier at higher price. Two distinct structures could be assumed for pricing, one with static implementation, where customers bid in advance and choose a ranking order with a corresponding price where delivery is contingent on the realized demand (Plan A), and another with dynamic markdowns where price plunges down until it reaches a certain price floor or it sells out (Plan B). For the case of linear utilities, we show that for any optimal mechanism A, there exists an equivalent scheme, B, which is implemented dynamically and according to a preannounced price path.

In the simple case of a two period sale, for instance, the monopolist decides to sell at P_H in period one, and if any product left, at P_L in period 2. A consumer buys at the first period if utility of purchasing at the higher price is greater than buying cheaper but with higher risk of unavailability. In other words, the customer purchases the product earlier if the following IC[5] condition holds for the case of risk neutral customers: $q_1 v_i - P_H \geq q_2 v_i - P_L$ where q_i is the probability of obtaining the good in period i.

We start by solving for the optimal mechanism. We show that the monopolist can obtain maximum attainable profit by running mechanism A and that there exists an equivalent B scheme (5 markdowns in the example by Figure 1.1). When offered a menu of priority services, we show that customers who choose higher prices, are served with more certainty or with superior priority in equilibrium. Buyers signal about their types by choosing a service ranking between 1 and N, where each ranking order corresponds to a purchas-

[5] Incentive Compatibility or Self Selection.

ing time or markdown if the product is not sold out by then. We consider the earlier steps as higher priority orders with more certainty in obtaining the product. One should note that we assume that a smaller service ranking, r, corresponds to higher probability of being served. We show that the monopolist serves the customers based on their service orders, i.e., the people who have chosen higher payments are prioritized over the people who have committed to pay less[6]. Also, as we will discuss, the retailer may not be willing to serve all customers. In other words, the seller might be willing to serve the customers who declare types greater than θ_T, which we call as the cutoff type. Thus, optimal number of steps could be lower than N in equilibrium.

Recall that a truthtelling strategy means that the best strategy for a customer is to reveal her true type, $v_i \in \{\theta_1, ..., \theta_N\}$, given that everybody else is truthful. Therefore, the following Incentive Compatibility conditions should hold for the truthful customer i for all possible types $v_i = \theta_l$ (where $r_l = r(\theta_l)$ is the corresponding truthtelling ranking choice):

$$E_{-i}[g_i(r_l, r_{-i})\theta_l - t_i(r_l, r_{-i})] \geq E_{-i}[g_i(\hat{r}_i, r_{-i})\theta_l - t_i(\hat{r}_i, r_{-i})] \quad \forall l, \hat{r}_i \in \{1, ..., N\}, \tag{1.6}$$

or equivalently

$$q_i(r_l)\theta_l - p_i(r_l) \geq q_i(\hat{r}_i)\theta_l - p_i(\hat{r}_i) \quad \forall l, \hat{r}_i \in \{1, ..., N\}. \tag{1.7}$$

[6]As illustrated by Myerson (1981), Mas-Colell, Whinston and Green (1995) and Tirole (1988) the assumption is valid under two conditions when customers are drawn independently from an identical distribution. First, the utility function be concave and strictly increasing, and second, the hazard rate of the distribution function be increasing in type/valuation. The former is satisfied by assuming that the customers are risk neutral, and the latter is true for a large class of distributions, including normal, uniform, etc.

Furthermore, the seller can not force the buyers to participate in the pricing scheme. Therefore, in addition to the incentive compatibility conditions, the mechanism should also provide the participants with at least their outside utility (Individual Rationality or IR condition). The outside utility is called "outside option" or "reserve utility" and is normalized to zero:

$$E_{-i}[g_i(r_l, r_{-i})\theta_l - t_i(r_l, r_{-i})] \geq 0 \qquad IR\ Condition, \tag{1.8}$$

or equivalently

$$q_i(r_l)\theta_l - p_i(r_l) \geq 0. \tag{1.9}$$

Before solving the monopolist's revenue maximization problem, one should note that the solution is be symmetric across the individuals. The reason is that all valuations are independently and identically distributed. Therefore, if a set of reports r' can be obtained by rearranging r, then any individual who reports x in the first set, r will be treated with the same allocation and transfer rule as any individual with the same report in the set r'. To express the symmetry in terms of equations:

$$g_i(r_i = x, r_{-i}) = g_j(r'_j = x, r'_{-j}),$$

$$t_i(r_i = x, r_{-i}) = t_j(r'_j = x, r'_{-j}).$$

The symmetry of the solution implies that expected payment and allocation to different individuals with the same ranking should be the same, too. Therefore, index i can be dropped from $q_i(.)$ and $p_i(.)$ in the IC and IR

conditions (Equation 1.7 and Equation 1.9, respectively) and we denote by $q(.)$ and $p(.)$ from now on.

Now, we can state the monopolist's problem in terms of solving for the optimal choice among the set of truthtelling allocation rules and transfers $< g(r), t(r) >$ - the choice that maximizes his expected revenue. In mathematical terms, we can express the merchant's problem as:

$$Max\ ME_{r_l}E_{-i}[t_i(r_l, r_{-i})] = \ ME_{r_l}p(r_l) = \ \frac{M}{N}\sum_{k=1}^{N}p(r_k) \tag{1.10}$$

$$maximized\ over < g(r), t(r) >$$

$$subject\ to\ IC\ and\ IR\ conditions,$$

where E_{r_l} is the expectation over the uncertain ranking/valuation of the customer (from the point of view of the seller), and E_{-i} is the expectation from the point of view of customer i with valuation $v_i = \theta_l$ who observes the reservation prices of other customers as unknown. The solution technique includes two steps. First we ignore a number of constraints and solve the maximization problem. Then, having solved the maximization problem and after finding the allocation rule, we show that the ignored constraints are satisfied. The constraints to put aside are individual rationality (IR) constraints of all types except the lowest participating type θ_T, and all but one incentive compatibility (IC) condition of every customer. The IC and IR constraints to ignore are:

$$E_{-i}[g_i(r_l, r_{-i})\theta_l - t_i(r_l, r_{-i})] \geq 0 \ \ \forall l \neq T,$$

and

$$E_{-i}[g_i(r_l, r_{-i})\theta_l - t_i(r_l, r_{-i})] \geq E_{-i}[g_i(\hat{r}_i, r_{-i})\theta_l - t_i(\hat{r}_i, r_{-i})]$$

$$\forall l, \hat{r}_i \in \{1, ..., N\} \ such\ that\ \hat{r}_i \neq r_{l-1},$$

which means that, for each customer with valuation θ_l, it is sufficient to only consider the condition that reporting r_{l-1} and mimicking the closest smaller type, θ_{l-1}, is not profitable for her. Using all the simplifying assumptions, one could solve for the optimal set of contracts and obtain the following priority pricing scheme:

Theorem 1.2.2. *Optimal scheme is priority pricing with a cut-off rank T, where priority prices are $\{p^*_T, p^*_{T+1}, ..., p^*_N\}$. The prices are paid upfront and customers participate in a lottery-type sale in which their payments may not result in the delivery of the product. Any customer with valuation $\theta_l \geq \theta_T$ chooses the option $< r_l, p^*_l >$ from the menu and receives the product at price p^*_l if no higher value customer is present in the market. Optimal allocation rule, $g_i(r_i, r_{-i})$, and cut-off rank T are defined by:*

$$g_i(\hat{r}_i, \hat{r}_{-i}) = \begin{cases} 0 & if\ \exists\ j\ such\ that\ \ \hat{r}_j > \hat{r}_i \\ 1 & if\ \nexists\ j\ such\ that\ \ \hat{r}_j \geq \hat{r}_i \\ \frac{1}{K} & if\ \exists\ K\ number\ of\ j\ such\ that\ \hat{r}_j = \hat{r}_i\ and\ \hat{r}_i = max_k\{\hat{r}_k\}, \end{cases} \tag{1.11}$$

where $i, j, k \in \{1, ..., M\}$, and $T = ArgMin_l\,\{\theta_l - (N-l)\Delta_{\theta_l}\}$ such that $\{\theta_l - (N-l)\Delta_{\theta_l} \geq 0\}$, and prices are obtained by:

$$p^*_l = \theta_l q(r_l) + \sum_{j=T}^{l-1}(\theta_j - \theta_{j+1})q(r_j) \ \ given\ \ q(r_l) = E_{-i}[g_i(r_l, r_{-i})]. \tag{1.12}$$

Proof. Given the linearity of utility functions and the symmetry assumption that customers are drawn independently from an identical distribution, we can denote the expected payment of choosing ranking r by $p(r) = p_i(r)\ \forall i$, which is the same across all individuals. It simplifies our analysis since there will be no heterogeneity among the customers, and hence, one can take expectations of the equations without worrying about differences across individuals. Therefore, the maximization problem and the constraints reduce to the following:

$$Max\ ME_{r_l}p(r_l) = \frac{M}{N}\sum_{k=1}^{N} p(r_k) \tag{1.13}$$

$$maximized\ over < g(r), \{p(r_k)\} >$$

$$subject\ to\ q(r_l)\theta_l - p(r_l) \geq q(\hat{r}_i)\theta_l - p(\hat{r}_i)\ \ (IC)$$

$$\forall l, \hat{r}_i \in \{1, ..., N\}\ such\ that\ \hat{r}_i = r_{l-1}$$

$$and\ q(r_l)\theta_l - p(r_l) \geq 0\ \forall l \in \{1, ..., N\}\ \ (IR).$$

Note that prices are total expected payments and not prices contingent on delivery. Before solving the maximization problem, one can see that if the participation constraint for a customer with valuation θ_T holds, then all the IR constraints for the others can be ignored. It is easy to show that if the IR constraint for θ_l and the incentive compatibility condition for θ_{l+1} hold, i.e.,

$$q(r_{l+1})\theta_{l+1} - p(r_{l+1}) \geq q(r_l)\theta_{l+1} - p(r_l)\ and\ q(r_l)\theta_l - p(r_l) \geq 0.$$

Then, since $\theta_{l+1} > \theta_l$, the IR condition holds for θ_{l+1} automatically, i.e., $q(r_{l+1})\theta_{l+1} - p(r_{l+1}) \geq 0$. Therefore, it is sufficient to consider only the individual rationality constraint of the lowest type, θ_T. Given the IR constraint for θ_T, the optimal price p_T^* will be:

$$p_T^* = q(r_T)\theta_T. \tag{1.14}$$

One can see that the other incentive compatibility conditions should hold with equality to maximize revenue. Therefore, price $p(r_l)$ is obtained by iteratively plugging the price $p(r_{l-1})$ in the IC condition of customer with valuation $v_i = \theta_l$:

$$p(r_l) = \theta_l q(r_l) + \sum_{j=T}^{l-1}(\theta_j - \theta_{j+1})q(r_j). \tag{1.15}$$

The next step includes plugging optimal prices in Equation 1.13 and solving the maximization problem:

$$Max\ ME_{r_l}[\theta_l q(r_l) + \sum_{j=T}^{l-1}(\theta_j - \theta_{j+1})q(r_j)] \tag{1.16}$$

$$maximized\ over < g(r), T > .$$

The expectation term could be written as the sum of all possibilities as:

$$Max\ M\frac{1}{N}\sum_{l=T}^{N}[\theta_l q(r_l) + \sum_{j=T}^{l-1}(\theta_j - \theta_{j+1})q(r_j)], \tag{1.17}$$

which is equal to:

$$Max\ \frac{M}{N}\sum_{l=T}^{N-1}[q(r_l)(\theta_l + (N-l)(\theta_l - \theta_{l+1}))] = \frac{M}{N}\sum_{l=T}^{N-1} q(r_l)(\theta_l - (N-l)\Delta_{\theta_l}) \tag{1.18}$$

$$= \frac{M}{N}\sum_{l=T}^{N-1} q(r_l)\psi(\theta_l),$$

where $\Delta_{\theta_l} = \theta_{l+1} - \theta_l$. The equation above implies that if valuations be equally distanced from each other, then Δ_{θ_l} will be a constant term. Therefore, the coefficient of $q(r_l)$ - defined as $\psi(\theta_l) = \theta_l - (N-l)\Delta_{\theta_l}$ - will be increasing in l. Since the profit function is linear in the $q(r_l)$ terms, then it is optimal to make $q(r_N)$ as big as possible. Given, $q(r_N)$, then it is optimal to make $q(r_{N-1})$ as big as possible. The allocation rule continues in the same way until the seller stops before allocating anything to type $T-1$ for whom the coefficient of $q(r_{T-1})$ becomes negative. Therefore, the allocation rule includes a priority scheme denoted by Equation 1.11 where T is obtained from solving:

$$T = ArgMin_l \{\theta_l - (N-l)\Delta_{\theta_l}\} \textit{ such that } \{\theta_l - (N-l)\Delta_{\theta_l} \geq 0\}. \tag{1.19}$$

$\square$

In other words, a customer who chooses the option $< r, p(r) >$, will be served if no other customer chooses a higher price with a higher priority. It is interesting to study some special cases for our equilibrium:

- If you let population be too big, i.e. $M \to \infty$, then posted price will be optimal. In other words, with big populations, seller is almost confident that there is somebody with the highest possible valuation, and therefore, sets a single price (known as posted price) equal to the highest possible valuation $p = 1$.

- If you let $N \to \infty$, the distribution of the customer approaches a continuous distribution and virtual valuation can be calculated as $\psi(\theta_l) = 2\theta_l - 1$.

The $\psi(.)$ function is the same as virtual valuation obtained by Myerson (1981), Wilson (1989), and Mas-Colell et al. (1995) for continuous distribution functions, i.e. $\theta_l - \frac{1-F(\theta_l)}{f(\theta_l)}$, which will be equal to $2\theta_l - 1$ for a uniform distribution in our study.

Theorem 1.2.3. *Priority pricing could be implemented by offering a menu of options with rankings and payments conditional on receiving the product. The set of prices are* $\{\tilde{p}^*_T, \tilde{p}^*_{T+1}, ..., \tilde{p}^*_N\}$ *defined by:*

$$\tilde{p}^*_l = \frac{p^*_l}{q^*_l}, \tag{1.20}$$

where p^*_l *and* q^*_l *are equilibrium priority price and probability of being served for customer who chooses ranking order* r_l *specified according to Theorem 1.2.2.*

Proof. The proof is very straight forward by stating that customers are risk neutral and only care about expected utilities. Utility functions are quasilinear, and therefore, one should redo the proof for Theorem 1.2.2 by using the new utility functions after rewriting them in terms of contingent prices, $\tilde{p}^*_l$:

$$q^*(r_l)(\theta_l - \tilde{p}^*_l) = q^*(r_l)\theta_l - p^*_l$$

□

This theorem and the following theorem (that provides an equivalent mechanism to priority pricing) explain how online retailers, "pricetack.com" and "pricefalls.com" for instance, find it optimal to implement markdown pricing with payments conditional on the delivery of product.

Theorem 1.2.4. *When customers are risk neutral, for any priority pricing A with a menu of options $< r_l, \tilde{p}_l^* >$ with contingent payments, there exists an equivalent markdown scheme, B. In mechanism B, prices fall according to the same path, $< \tilde{p}_l^* >$, and yield to the same total revenue.*

Proof. For any option, $< r_l, p_l^* >$, in plan A, customer with valuation θ_l shall receive the product with probability q_l^* and will pay $\tilde{p}_l^*$ contingent on delivery. Therefore, expected utility will be:

$$q_l^*(\theta_l - p_l^*).$$

Alternatively, the monopolist could implement a markdown scheme, B, in which price of the product declines according to the pricing scheme $< \tilde{p}_N^*, \tilde{p}_{N-1}^*, ..., \tilde{p}_T^* >$. In this case, prices decline every period according to a preannounced schedule. If a customer wants to wait until a later period to purchase the item, she will expect to pay lower but will also face higher risk of unavailability. Initial price will be $\tilde{p}_N^*$, and given that any customer with type θ_{N-1} purchases the product in period 2 at price $\tilde{p}_{N-1}^*$, it attracts the highest value customers, θ_N, to purchase the product at the initial price. This is because all the IC and IR conditions of the customers are the same as those in the mechanism with priority pricing.

If no customer has the valuation θ_N and price declines to θ_{N-1} in the following period, customers will update their beliefs with the information that there is no person with valuation θ_N. Therefore, one could use Bayesian update to find the new distribution function, $f_n(.)$, for any remaining possible valuation $l \in \{1, 2, ..., N-1\}$:

$$f_n(\theta_l) = \frac{f(\theta_l)}{F(\theta_{N-1})}.$$

Given the new distribution function and that any customer with valuation θ_l waits for price $\tilde{p}_l^*$ to purchase the product, all individuals including the customer with valuation θ_{N-1} will update her beliefs, and the incentive compatibility inequalities will change accordingly. The conditions will change only in that the new set of q_l^* will be obtained by using the new distribution function $f_n(.)$. One should note that since customers' utilities are quasilinear, all the IC conditions stay the same. Therefore, customer θ_{N-1}'s behavior will be the same and she will choose to purchase the product at period 2, if available. Similarly, if there were no sales in the first two periods, beliefs will be updated correspondingly, IC conditions will stay unchanged in the same way, and customer with valuation θ_{N-2} will still choose to buy the product at $\tilde{p}_{N-2}^*$. The argument continues in the same way until we show that individuals with valuation θ_T will choose to purchase at a price equal to their maximum willingness to pay, $\tilde{p}_T^* = \theta_T$.

We complete the proof by stating that since mechanism A is optimal, and because mechanism B leads to equivalent strategies and prices, then markdown pricing leads to the same optimal profit as well.

□

1.2.2 Multiunit Markdowns

Theorem 1.2.5. *When the seller has a total of $S < M$ units, optimal allocation rule is an upfront payment or priority pricing where allocation rule is defined by:*

$$g_i(\hat{r}_i, \hat{r}_{-i}) = \begin{cases} 0 & if\ C_{\hat{r}_i}(\hat{r}) \geq S \\ max\{1, \frac{S - C_{\hat{r}_i}(\hat{r})}{K}\} & if\ C_{\hat{r}_i}(\hat{r}) < S\ and\ \exists\, K\ number\ of\ j\ such\ that\ \hat{r}_j = \hat{r}_i, \end{cases} \tag{1.21}$$

where $C_{\hat{r}_i}(\hat{r})$ is the number of people who choose a ranking order strictly higher than $\hat{r}_i$, $i, j \in \{1, ..., M\}$, and $\hat{r}_i, \hat{r}_j \in \{1, ..., N\}$. Furthermore, prices are the same as in the case with only one unit presented by Equation 1.12.

Proof. The monopolist's maximization problem is the same as the problem in Theorem 1.2.2 with identical incentive compatibility and individual rationality constraints. However, the difference is that the number of available units for sale is more than one. Therefore, the seller allocates more than one unit rather than only one unit to the bidders. Similarly, because the maximization problem is a linear equation with bigger coefficients on the expected probability of delivery to the higher ranked customers, the monopolist adopts a similar priority scheme. He starts with allocating the units to the highest order customers, r_N, and charges them p_N. Then, the monopolist allocates the leftover to the customers with the next highest ranking order, r_{N-1} and charges them p^*_{N-1}. The seller continues delivering the products to the customers based on their orders until it completely sells out. A tie-braking rule is also adopted. When number of individuals demanding the product at the current price level becomes greater than the number of units left, customers are served with equal chances. We complete the proof by stating that the price equations will remain the same since incentive compatibility and individual rationality constraints mechanism remain the same in the new truthtelling . □

However, since markdown pricing reveals information to the customers at every step, it is not optimal to implement it in a dynamic setting. At every single period, few items may be sold, and depending on the number of items left, incentives of customers will be altered in the following period. Therefore, if the seller sticks to a preannounced price schedule and reveals information regarding the number of items left, the scheme will not be optimal for most distributions of demand. However, there are alternatives via which seller can obtain optimal profit. The monopolist should either hide any information regarding the quantity sold and left or modify markdown scheme, and instead, implement a priority pricing schedule. These arguments let us state with the following theorem:

Theorem 1.2.6. *Seller with multiple units of product should implement specific forms of markdown pricing to achieve optimal revenue. First is to hide the number of available supply during the whole plunging process. And second is to offer priority services in which customers choose the price level in advance and pay conditional on receiving product.*

Our analysis shows that when a seller has multiple units for sale, he should sell them via either priority pricing scheme or hiding information regarding the availability. The first mechanism is implemented in the beginning period and before the realization of uncertainties. Higher ranked customers receive the product with greater probabilities but at higher prices. And the second method hides the number of remaining products at each stage so that customers' incentives are not distorted. This way, they do not get information regarding the number of units sold in the previous periods and the quantity remaining at each stage.

1.3 Risk Aversion

In this section, we assume that customers are risk averse and denote their utility by a strictly increasing and concave function, $u(x) = -e^{-\alpha x}$, with constant absolute risk aversion (CARA). The retailer is risk neutral and cares only about the expected revenue. The utility of choosing $\hat{r}_i$ among the available menu of ranking orders is defined by Equation 1.3. Similar to the solution technique in the previous section, we use the revelation principle and search over the set of truthtelling equilibria. The maximization problem, after ignoring the unnecessary IC and IR constraints, will be the optimal choice of allocations and transfers, $< g(r), t(r) >$, to solve the following problem:

$$Max\ ME_{r_l}E_{-i}[t_i(r_l, r_{-i})] \tag{1.22}$$

$$E_{-i}[u(g_i(r_l, r_{-i})\theta_l - t_i(r_l, r_{-i}))] \geq E_{-i}[u(g_i(\hat{r}_i, r_{-i})\theta_l - t_i(\hat{r}_i, r_{-i}))] \ \ (IC)$$

$$E_{-i}[u(g_i(r_l, r_{-i})\theta_l - t_i(r_l, r_{-i}))] \geq 0 \ \ (IR)$$

$$\forall l, \hat{r}_i \in \{1, ..., N\} \ such\ that\ \hat{r}_i = r_{l-1}.$$

The following theorem provides the optimal allocation rule in the new framework where customers are risk averse:

Theorem 1.3.1. *When customers are risk averse with CARA utility function, $u(x) = -e^{-\alpha x}$, producer adds insurance options to the markdown scheme. Retailer offers a menu of priority rankings and upfront payments $< r_l, \bar{p}_l >$, where each ranking r_l is supplemented with $\theta_l = r^{-1}(r_l)$ units of insurance I_{r_l}:*

$$I_{r_l}(C_l(r); S) = \begin{cases} 1 & if\ S \leq C_l(r) \\ 1 & if\ S > C_l(r)\ and\ g_i(r_l, r_{-i}) = 0 \\ 0 & if\ otherwise, \end{cases} \tag{1.23}$$

where $C_l(r)$ is the number of people who are served before r_l. Optimal allocation rule is the same characterized by Equation 1.21 and the set of priority price, $\{\bar{p}_l\}$, is obtained by iterative solution of the following equalities with $\bar{p}_T = \theta_T$:

$$\bar{p}_{l+1} = \theta_{l+1} - u^{-1}(E_{-i}[u(g(r_l, r_{-i})\Delta_{\theta_l} + \theta_l - \bar{p}_l)]). \tag{1.24}$$

Proof. The seller is risk neutral and designs a contract to maximize total expected profit. On the other hand, customers are risk averse. For a risk averse buyer, an allocation that delivers a certain average utility is superior to any original allocation that delivers an uncertain utility with the same expected payoff. Therefore, using the specific CARA property of the utility function, it is straightforward to show that optimal allocation requires that the risk neutral monopolist bears the risk in equilibrium.

The mechanism allows the retailer to implement any set of money transfers. Therefore, the seller who is willing to bear all or a portion of customers' risks, will consider offering payments to the customers in the form of insurance contracts. We show that the ability to make insurance transfers enables the seller to extract the maximum possible surplus from the demand side.

One unit of insurance, I_{r_l}, costs $\tilde{p}_{r_l}$. It provides one unit of payment for a customer with ranking order r_l when demand by higher order customers is too high to serve him. If customer i with type θ_l supplements her choice, $< r_l, t_i(r_l, r_{-i}) >$, with x_i units of the corresponding insurance, $< I_{r_l}, \tilde{p}_{r_l} >$, her expected utility will be:

$$U(r_l, x_i; \theta_l) = E_{-i}[u(g_i(r_l, r_{-i})\theta_l - t_i(r_l, r_{-i}) + I_{r_i}x_i - x_i\tilde{p}_{r_i})]. \tag{1.25}$$

Full insurance of the customer requires that:

$$I_{r_l} = 1 - g_i(r_l, r_{-i}),\ t_i(r_l, r_{-i}) = p(r_l),\ x_i = \theta_l, \tag{1.26}$$

which means that the optimal insurance should provide θ_l units of insurance to a customer with valuation θ_l, and should pay him when he does not receive the product. Furthermore, the transfer function $t_i(r_l, r_{-i})$ should be independent of the choices of other customers. Therefore, it can be denoted by $p(r_l)$, a function that depends only on the customer's own choice. Therefore, the utility function will become:

$$U(r_l, x_i = \theta_l; \theta_l) = u(\theta_l - p(r_l) - \theta_l\tilde{p}_{r_l}). \tag{1.27}$$

We follow the same steps as in the proof for the Theorem 1.2.2. We combining priority price with insurance premium and denote total payment for choice l by $\bar{p}_l = p(r_l) + \theta_l \tilde{p}_{r_l}$. Considering that the lowest participating customer, the cut-off type with valuation θ_T, obtains zero expected utility in equilibrium, one can obtain $\bar{p}_T = \theta_T$. Incentive compatibility conditions hold with equality and give us equilibrium prices. Payment by type θ_{l+1} can be obtained by repetitive iterations of the IC conditions (starting from the IC condition of the customer with type θ_T):

$$u(\theta_{l+1} - \bar{p}_{l+1}) = E_{-i}[u(g(r_l, r_{-i})\theta_{l+1} + (1 - g(r_l, r_{-i}))\theta_l - \bar{p}_l)]. \tag{1.28}$$

The equation above has a unique solution where $\bar{p}_{l+1} > \bar{p}_l$. It is because the utility function is strictly increasing and we have:

$$g(r_l, r_{-i})\theta_{l+1} + (1 - g(r_l, r_{-i}))\theta_l < \theta_{l+1},$$

which means that the customer pays an upfront amount, receives an insurance and becomes indifferent between receiving and not receiving the product. Rewriting Equation 1.28, one can obtain:

$$\bar{p}_{l+1} = \theta_{l+1} - u^{-1}(E_{-i}[u(g(r_l, r_{-i})\Delta_{\theta_l} + \theta_l - \bar{p}_l)]),$$

and the iterative solution of each price in terms of the lower price gives us:

$$\bar{p}_{l+1} = \theta_{l+1} - u^{-1}(E_{-i}[u(g(r_l, r_{-i})\Delta_{\theta_l} + u^{-1}(E_{-i}[u(g(r_{l-1}, r_{-i})\Delta_{\theta_{l-1}} + ...)]))]). \tag{1.29}$$

Assuming that the valuations are equally distanced, i.e., $\Delta_{\theta_l} = \Delta \ \forall l$, prices can be used to rewrite the maximization problem as:

$$Max\ M\frac{1}{N}\sum_{l=T}^{N}\{\theta_{l+1} - u^{-1}(E_{-i}[u(g(r_l, r_{-i})\Delta_{\theta_l} + u^{-1}(E_{-i}[u(g(r_{l-1}, r_{-i})\Delta_{\theta_{l-1}} + ...)]))])\} \tag{1.30}$$

$$maximized\ over < g(r), T > .$$

According to the new maximization problem, it is sufficient to define the allocation rule and cut-off rank to solve for the optimal scheme. Customers have strictly increasing and concave utility functions, and therefore, inverse utility function $u^{-1}(.)$ is also strictly increasing. Therefore, it becomes easy to see that solving the maximization problem includes making $g(r_N, r_{-i})$ as large as possible. Then, given $g(r_N, r_{-i})$, one should make make $g(r_{N-1}, r_{-i})$ as big as possible and continue until the cut-off rank gets served by the allocation rule, $g(r_T, r_{-i})$. Therefore, the optimal allocation rule will be the same as in the case with risk neutral customers (Equation 1.21), where the seller implements priority pricing with higher ranked customers served first. To obtain the cut-off rank, one should note that it is not possible to provide a close form solution and it should be obtained by computing and comparing Equation 1.30 for different values of T. □

As suggested by Equation 1.23, one unit of insurance I_{r_l} provides one unit of payment transfers in case demand is too high to serve a customer with ranking order r_l. In other words, the insurance pays to the customer if realized number of customers with higher ranking orders, denoted by $C_l(r)$, become greater than total supply S.

Therefore, customers bear no risk by transferring all the uncertainties to the monopolist. The intuition behind the optimal equilibrium is that producer is risk neutral and customers are risk-averse. Thus, the optimal equilibrium includes contracts where the seller compensates customers' uncertainties by insurance, and in return, gets paid higher in expected terms.

As implied by the theorems 1.3.1 and 1.2.2, the monopolist chooses market coverage by designing a contract where no customer with valuation lower than θ_T is willing to participate. By choosing the lowest service order, he decides what portion of market to serve. An appealing operational implication is for situations when demand by the participating customers falls below the supply level. The exceeding amount will be thrown away or unsold, and customers with lower valuations will not be served by any kind of clearance sales - what we call as "commodity burning". Such experiments are seen, for instance, in airlines' ticket sales. United Airlines, for example, would fly with fully occupied coach seats and empty business class seats if it turns out that the demand for the latter is low. Or as another instance, Filene's basement was willing to give the remaining items to charity after a specific date if unsold until then (Figure 1.3). In such examples, seller forgoes profit from last minute sales. By committing to a preannounced pricing schedule, supplier extracts more from high value customers who are incentivized to purchase the product at higher prices.

Theorem 1.3.1 states that upfront payment schedule combined with insurance yields to higher profit relative to pricing schemes with no insurance. By insuring customers against losses, seller can extract more ex-ante surplus from the market. It is because risk averse buyers pay higher in expected terms if asked to pay in advance for a certain quality of service relative to the contracts where they should pay after the uncertainties are realized. Therefore, an operational advice for producers is to bear more risk and offer insurance schemes in order to maximize profits when customers are sensitive towards disruptions or availability of product.

One should note that total upfront payment, $\bar{p}_l$, includes both insurance premium and the price for the delivery of the product. Therefore, we can decompose total payment into two segments: insurance premium $\tilde{p}_{r_l}$ per unit insured and payment for the priority service $p(r_l)$:

$$\bar{p}_l = p(r_l) + \theta_l \tilde{p}_{r_l}.$$

Insurance I_{r_l} pays off when the product is not allocated to the customer, i.e., $g(r_l, r_{-i}) = 0$ or $I_{r_l} = 1$. In addition, expected payoff of one unit of the insurance is equal to its premium:

$$\tilde{p}_{r_l} = E_{r_{-i}} I_{r_l}(C_l(r); S). \tag{1.31}$$

Therefore, payment for the priority service can be stated as:

$$p(r_l) = \bar{p}_l - \theta_l \tilde{p}_{r_l}. \tag{1.32}$$

In all, total upfront price can be seen as two separate payments: payment for the priority service and insurance against the risk of unavailability. The seller's optimal strategy is to offer contingent contracts with upfront payments and supplementary insurance in order to maximize his expected revenue. And risk averse customers participate in a lottery-type mechanism where they may not receive the product if demand becomes too high.

1.4 Conclusion

We study the revenue maximizing pricing schedule of a monopolist in the presence of uncertain demand and against heterogeneous customers who may differ in their valuations for the product. When customers are risk neutral, previous studies find that the optimal mechanism consists of a single, two, or maximum three step pricing schedule. This paper differs from the literature by considering a more realistic structure of uncertain demand and case where supply contains multiple units of product. In addition, it considers the scenarios where seller commits to a pricing path in the future. In so doing, we contribute to the literature in the following ways.

First, we are able to illustrate that the optimal policy is to price discriminate via performing multistep markdown pricing or priority schemes. Markdown pricing is implemented when the valuations of customers are discrete, as performed by "pricetack.com" or "pricefalls.com" websites. The pricing schedule is preannounced in the sense that the price path is introduced in the beginning of the horizon. On the other hand, priority scheme could be carried out via an auction with simultaneous bids when supplier prefers to collect sealed bids and allocate the products in a single period. Both falling price schedule and priority options incentivize higher value customers to purchase at higher prices, and therefore, enable the monopolist to extract more surplus from market. This is because each customer must decide either to buy the product at a higher price or at a lower price but with a certain risk. In the "pricetack.com" case, customer may wait to purchase the item at a discounted rate but will face the risk of the product selling out during the sales season. We show that when there is a single unit of supply, dynamic sales with a pre-announced price path performs as well as the optimal mechanism in which the seller offers menu of ranking-price options. However, we find that it is not optimal to implement a scheme with plunging prices when there are multiple units of supply unless the seller hides any information regarding the quantity sold and quantity remaining at each period. The lower revenue of dynamic pricing, when supply information is revealed, is due to the revelation of information to customers. They update their strategies at every single sale period after they observe the number of quantities sold and the amount left. Fortunately, there are two ways seller can avoid this and achieve optimal revenue. First is to hide number of available supply at every single period except the beginning supply which is a common knowledge. And second is to implement a specific form of modified priority pricing in which customers choose their desired price in the beginning and are charged conditional on receiving the product. To implement this, seller may receive each customer's choice and credit card information in the beginning, allocate the goods according to their ranking orders and charge each one with the corresponding price if allocated the product. Finally, the monopolist's allocation rule is different from the efficient scheme in that "commodity burning" might be implemented in equilibrium. That is, if high value customers are too few to purchase the product at the very early stages, the monopolist may dispose of the goods rather than putting them up for sale at very low prices.

In addition, we show that when customers are sensitive to the availability of product or quality of service, represented by risk averse utility functions, there exists another pricing strategy that dominates the proposed multistep or priority pricing schedule. In this case, monopolist is offers contingent contracts, complemented by a menu of options with upfront payment and supplementary insurance, and serves the customers conditional on the realization of demand. A customer pays in advance for a product and risks loss of her money if she does not receive the product. On the other hand, seller offers her some reimbursement to insure her against the loss.

Future research should take into account more detailed allocation and pricing schemes that are made feasible by recent technological innovations, e.g., markdown pricing schemes with unknown price floor. Another direction is the introduction of unknown aggregate population which could significantly change the optimal pricing scheme. Furthermore, future studies need to take into account the possibility that seller knows the distribution of potential demand, but is unaware of the presence of customers in the market. For instance, the seller may know by experience the distribution of valuations of customers, but he might not know with certainty which customers need the product during the sale period.

Table 1.1: Summary of Related Research on Dynamic Pricing with Strategic Customers

Reference	Uncertainty	Includes Risk Aversion	Valuations[a]	Commitment[b]	Aggregate Demand
Aviv and Pazgal (2008)	Demand	No	Complete	Yes	Poisson Process with Known Rate
Elmaghraby et al. (2008)	Demand	No	Incomplete and Complete	Yes	Known and Finite
Harris and Raviv (1981)	Demand	No	Incomplete	Yes	Known and Finite
Horner and Samuelson (2011)	Demand	No	Incomplete	No	Known and Finite
Liu and Van Ryzin (2008)[c]	Demand	Yes	Incomplete	Yes	Known and Finite
McAfee and Vincent (1997)	Demand	No	Incomplete	No	Known and Finite
Skreta (2006)	Demand	No	Incomplete	No	Known and Finite
Stokey (1979)	None	No[d]	Complete	No	Known and Finite
Su (2007)	Demand	No[e]	Complete	Yes	Known and Continuum
Wilson (1989)	Supply	Yes	Complete	Yes	Known and Continuum
Present Paper	Demand	Yes	Incomplete	Yes	Known and Finite

[a] Under incomplete information, customers have privately known valuations drawn independently from a known distribution.

[b] The seller has commitment on pricing schedule.

[c] Seller has two periods to sell the product and has no power over determining the number of pricing steps in this paper. Seller's tools are deliberate rationing and prices in two period.

[d] Customers have waiting costs in this framework which could be heterogeneous.

[e] Customers have waiting costs in this framework, and they could be heterogeneous in terms of having different degrees of impatience.

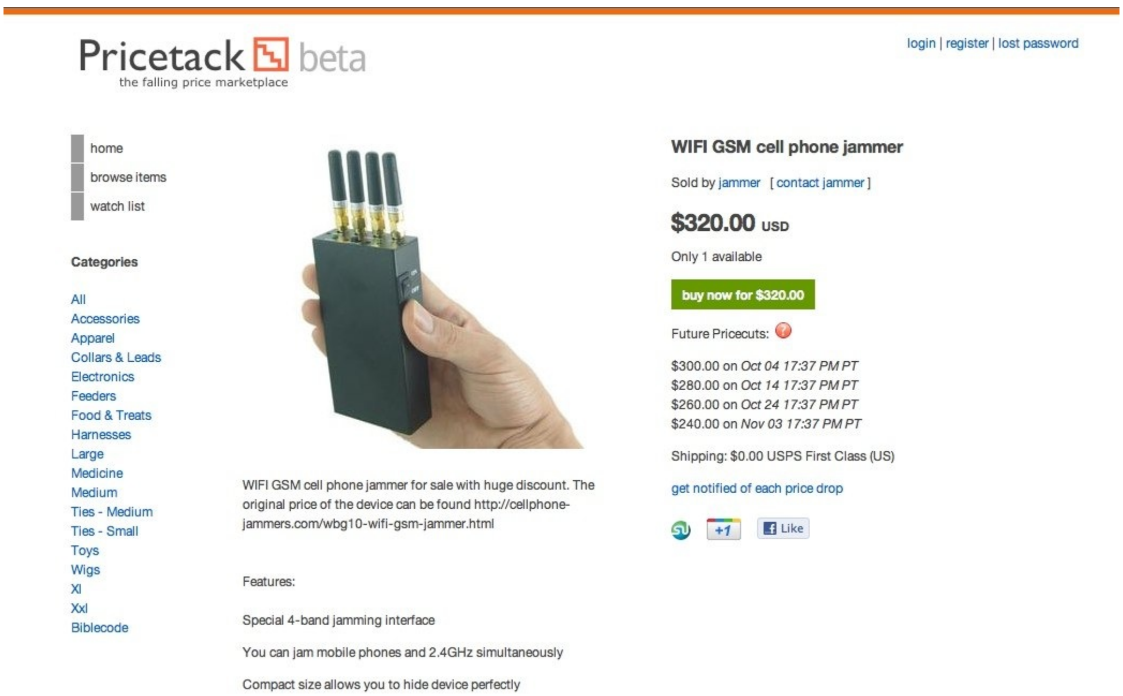

Figure 1.1: Cell Phone Jammer Sold by a Falling Price Schedule on "Pricetack.com"

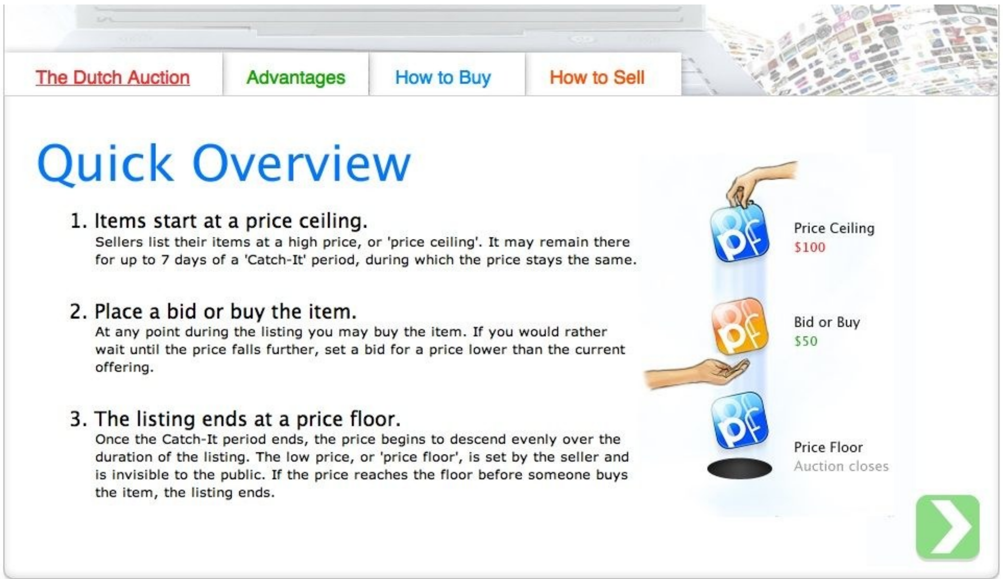

Figure 1.2: Markdown Pricing on "Pricefalls.com"

Figure 1.3: Filene's Basement

Figure 1.4: Aalsmeer Flower Auction

Chapter 2

The Finance and Growth Nexus Re-examined: Do All Countries Benefit Equally?

A large theoretical and empirical literature has focused on the impact of financial deepening on economic growth throughout the world. This paper contributes to the literature by investigating whether this impact differs across regions, income levels, and types of economy. Using a rich dataset for 150 countries for the period 19752005, dynamic panel estimation results suggest that the beneficial effect of financial deepening on economic growth in fact displays measurable heterogeneity; it is generally smaller in oil exporting countries; in certain regions, such as the Middle East and North Africa (MENA); and in lower-income countries. Further analysis suggests that these differences might be driven by regulatory/supervisory characteristics and related to differences in the ability to provide widespread access to financial services.

2.1 Introduction

It is well established that a vibrant, dynamic, and well-functioning financial sector leads to a host of improved economic outcomes. As surveyed first by Levine (1997a), then by Demirguc-Kunt and Levine (2008, 2009), there is a vast literature showing the benefits that accrue to countries in which financial development is greater. On the theoretical side, early work by McKinnon (1973) and Goldsmith (1969), among others, highlighted the key role in economic development that could be played by a banking system free of the types of controls on interest rates and quantities that were prevalent at the time. As the literature progressed, it began to recognize that the financial system in generalnot exclusively banksperformed four basic functions essential to economic development and growth: mobilization of savings, allocation of resources to productive uses, facilitating transactions and risk management, and exerting corporate control. Through these functions, a country providing an environment conducive to greater financial development would have higher growth rates, with much of the effect coming through greater productivity rather than a higher overall rate of investment.

The empirical literature progressed in tandem, providing widespread evidence that financial depththe extent to which an economy is making use of bank intermediation and financial market activityis associated with higher rates of economic growth. In order to measure financial depth, several indicators have been used. For the banking sector, the ratio of liquid liabilities to GDP, or M2 to GDP, and of private sector credit to GDP. For stock market activity, market capitalization to GDP, the ratio of value of shares traded either to GDP or total capitalizationboth measures of the turnover of market activityhave also been used.

Several different econometric methodologies have been employed to uncover this finance and growth nexus.[1] Early studies such as King and Levine (1993) and Levine and Zervos (1998) used a cross-country regressionthe former focusing on bank-based measures, and the latter on market-based onesand controlled for other possible growth determinants and the Solow-Swan convergence effect. To deal with potential reverse causalitythat some degree of financial development might possibly be induced by a greater demand for financial services as economies become richersome studies have regressed growth rates over a relatively long period on initial values of financial depth. Later studies by Levine (1998) and Levine, Loayza and Beck (2000) use instrumental variable techniques to address the endogeneity issue in a panel data setting. Finally, other studies have used dynamic panel methodologies. Beck, Levine and Loayza (2000), Rousseau and Wachtel (2000), and Beck and Levine (2004) rely on GMM estimators to trace the effect of financial development in markets and banks on economic growth.

For the most part, the empirical studies on the determinants of growth have provided a single coefficient for all countries. However, there has also been increasing interest in examining possible sources of cross-country heterogeneity in these relationships. Khan and Senhadji (2000) and Khan, Senhadji and Smith (2001) use a wide sample of countries and find heterogeneity related to financial depth and inflation. The first paper finds threshold levels for inflation in industrial and developing countries above which inflation significantly slows growth, while the second one uncovers a threshold above which infla-

[1]See Levine (2004).

tion impedes financial deepening. More recently, Arcand, Berkes, and Panizza (2011) detect a nonlinear growth impact of banking depth, finding that it becomes progressively weaker as depth increases to very high levels. Eventually, when private sector credit exceeds 110 percent of GDP, the marginal effect of additional deepening on economic activity becomes negative, both at the economy and industry level.

Another type of heterogeneity could arise from a finance-related resource curse, whereby growth underperformance by natural resource exporters would be partly explained by financial sector underperformance. The resource curse generally refers to negative externalities from the predominant resource-exporting sector to the rest of the economy, operating through either the real exchange rate channel (the Dutch Disease phenomenon), through poor fiscal discipline, or as a result of political economy effects that lead to weak institutions and greater prevalence of corruption and violence.[2] Two recent studies described below go beyond these channels to examine the possible role played by the financial sector in resource-based economies, either ameliorating or contributing to the curse.

Nili and Rastad (2007) investigate a puzzle: the very low growth rates experienced by oil exporters over a 30-year period even while their investment rates are higher on average than in oil importing countries. The authors find

[2]For example, Klein (2010) studies a group of 23 oil-exporting countries during 19852008 and finds a significant negative impact of oil sector shocks on the non-oil sector in the countries with high oil intensity, and attributes this relationship to factors other than the traditional Dutch Disease channel operating through real exchange rate appreciation.

that finance helps to explain the puzzle in two ways: oil exporters tend to exhibit lower financial depth, and the positive impact of their financial depth on aggregate investmentand presumably on growthis substantially weaker than in non-oil exporting economies. Beck (2011) analyzes the case of resource-based economies in general, exploring whether there is a financial channel to the resource curse. He finds that, although the aggregate growth impact of banking depth is no different for resource-based economies, both private credit and stock market activity tend to be weaker, and access to credit for businesses is more limited in resource-based economies. There is evidence that banks in these countries are more profitablepossibly reflecting lower competitionbut are not as engaged in intermediating funds to the private sector.

In this paper we explore three dimensions of possible heterogeneity in the finance-growth nexus: across regions, between oil and non-oil exporters, and across income levels. Our dataset encompasses the 19752005 period and takes non-overlapping five-year averages of all variables to smooth out short-term fluctuations in growth rates and to reduce the potential bias arising from having a large number of time observations in dynamic panel estimation. The sample includes up to 146 countries included in some regressions, grouped by income level according to the IMF classification, and by oil and non-oil exporters depending on the share of oil in total GDP, which is also included in some regressions as the measure of oil dependence.

We find that, across regions, in Middle East and North Africa (MENA) countries banking sector depth produces a lower growth impact than in the rest of the world, while in Europe and Central Asia the impact is greater. This provides an additional explanatory factor underlying the well-documented subpar growth performance of the MENA region. For example, during 19752005, its real per capita GDP grew by an average 0.4 percent per year, compared to 2.4 percent for Emerging and Developing Countries (EDCs) on average, 5 percent in developing Asia, 1.1 percent in Latin America and the Caribbean, and 2.3 percent in Central and Eastern Europe (Figure 2.1). Previous studies have examined MENA growth underperformance and have linked it to such factors as shortfalls in institutional quality and ease of doing business, excessive government consumption, and in the case of oil importers, to lack of trade openness.[3] One study, by Bhattacharya and Wolde (2010) identified the lack of access to credit as one factor driving growth differentials between MENA and other regions, along with a shortage of labor skills and of adequate supply of electricity.[4] However, no other study had examined systematically whether the conventional positive link between finance and growth varies across regions, thereby at least partly explaining MENAs disappointing growth performance. Our results also suggest that the underperformance of the MENA region, termed a quality gap in financial intermediation, could be related to strong state ownership, lack of competition, and lack of progress in financial

[3]For example, Hakura (2004) examines MENA growth performance over 1980-2000 and Guillaume and Rasmussen (2011) focus on the MENA oil importers during the 1990-2008 period. Both use cross-country OLS regression analysis.

[4]All three variables are derived from the World Bank Enterprise Surveys, in which firms are asked whether different factors are considered a major constraint to their expansion: access to credit and/or lack of appropriate labor skills or of electricity supply.

reform.

We also find that the growth impact of banking depth is weaker for oil exporters in general, and is progressively weaker as the degree of oil dependence increases. However, there is evidence that growth impact of stock market depth may actually be higher in oil-exporting countries.

Finally, we find that, indeed, the finance-growth nexus is weaker for Low Income Countries (LICs) as a group, and that it increases continuously with income level. In particular, the estimated growth impact of the credit-GDP ratio is about half as large for LICs relative to other countries with similar depth, and appears to be actually negative at the lowest income levels, becoming significantly positive at about the 73rd percentile of income per capita for LICs in 2008. Other country characteristics appear to influence these effects as well; as is the case for the full sample of countries, oil-exporting LICs derive weaker growth from banking depth but possibly higher growth from stock market depth. Estimations show that LICs with higher-quality supervision or those that are more open to international trade fare relatively better than the rest. While by no means conclusive, we also present supporting data showing that financial access and some regulatory aspects regarding ease of entry may be related to the identified quality gap experienced by LICs. Thus, the policy message should be more nuanced for LICs: while greater depth in undoubtedly desirable, the challenge is to engender high-quality deepening that facilitates greater access, competition, and with proper supervision in place.

This effect, of course, exacerbates the fact that LICs suffer from shallow financial systems. For example, in 2008 the average LIC had a ratio of private credit to GDP of just over 24 percent, compared to 47 percent for Middle Income Countries (MICs) and 110 percent for High Income Countries (HICs). Similarly, LICs had ratios of stock market capitalization to GDP of 23 percent, substantially lower than the levels of 73 percent for MICs and 130 percent for HICs in the same year. What the growth regression results imply is that these countries may also lack the supporting legal, institutional, regulatory or supervisory infrastructure that would allow the greatest benefit to accrue from their existing levels of financial depth. Lack of competition and efficiency, both in the financial and real sectors, could play a part in weakening the growth impact as well.

The organization of the paper is as follows. Section 2.2 provides a description of the data and some noteworthy stylized facts; Section 2.3 outlines the econometric methodologies used and Section 2.4 presents the main results; Section 2.5 concludes and offers some plausible factors that might be driving the observed heterogeneity in the finance-growth relationship.

2.2 Data

2.2.1 Datasets

The data used in this study is composed of three datasets that provide annual country-specific observations from 1975 to 2005. The measures of financial development are provided by the Financial Structure Database constructed by World Bank. Standard financial depth indicators were employed:

private credit and turnover. Private credit measures the ratio of private credit by deposit money banks to GDP and turnover is the ratio of the value of total shares traded to average real market capitalization.[5]

Some variables, such as non-oil GDP, total GDP, and population were obtained from the World Economic Outlook (WEO) April 2010 published database. WEO includes data from IMF staffs projections and evaluations of economic development of all the member countries. In many cases this data was supplemented with series obtained directly from IMF desk economists on real non-oil GDP for oil-exporting countries.

The third database comes from the World Bank open source data. Total real per capita GDP of countries are extracted from this dataset to calculate the growth rate of countries as well as to use the initial levels of GDP in the regressions to control for the convergence effect. The values are in constant 2000 US dollars. Other variables include the percentage of gross secondary school enrollment to reflect human capital, and the ratio of FDI to GDP.

2.2.2 Stylized Facts

A list of the variables as well as their corresponding summary statistics is available in Tables 2.1 and 2.2 for the full sample of countries, in Tables 2.3

[5]For robustness, other financial depth indicators were also used: the ratio of bank deposits or liquid liabilities to GDP, and the ratio of stock market capitalization to GDP. However, here we only report the regression results including private credit and turnover, the two variables that have shown the most robust relationship with economic growth in the literature.

and 2.4 for the oil exporters, and in Table 2.5 for the regional and income-level groupings. Table 2.6 displays the results of tests for differences in means between: non-oil exporters and oil-exporters (first column), the Middle East and North Africa and all other countries (second column), LICs and all other countries (third column), and LICs and high-income countries (fourth column). Finally, Table 2.7 shows the correlations among the main variables. The list of countries is available in the Appendix, which also indicates which countries are oil exporters, as well as the country income group and regional classification.[6] Oildep measures the degree of oil dependence, and is defined as the ratio of non-oil GDP to total GDP, both in real terms. The statistics confirm the Nili-Rastad finding that oil exporters have shallower banking systems on average, as measured by the ratios of deposits and private credit to GDP (Nili and Rastad, 2007). They also have significantly lower average growth ratesof both oil and non-oil GDPthan non-oil exporters.

The means tests also reveal that LICs are at a disadvantage in virtually every dimension with the exception of FDI. Financial depth is significantly lower compared to the average across all other countries, as is the level of secondary enrollment and the growth rate.

As for cross-region differences, over the entire study period the MENA

[6]We generally followed the World Bank regional classification, but with one notable exception: GCC countries, which are classified by the World Bank in the high-income non-OECD category, are classified here together with the low and middle-income MENA countries. In this manner, the MENA category encompasses all countries in the region, both GCC and non-GCC.

region does not exhibit lower levels of secondary enrollment or FDI compared to other regionsthe p-values of the tests of differences in means are all well above 10 percenthowever, its growth performance has been significantly weaker (Figure 2.1). Moreover, the MENA countries on average do not appear to be particularly lacking in financial depth; average levels of bank deposits, private sector credit, or stock market turnover are not significantly different from those in the rest of the world. In fact, in 2008 the average private credit-GDP ratio for the region was, at 45 percent, higher than the emerging economy average of 38 percent, although well short of the 118 percent level typically observed in high-income countries (Figure 2.2a). Stock markets in MENA countries also appear to be relatively deep, with a turnover ratio of just under 40 percent in comparison to a world average of 54 percent and an EDC average of 40 percent.

However, three main qualifications should be made. First, there is considerable heterogeneity within the Middle East and North Africa. One way to see this is by slicing this region further, into a Mediterranean Associated Countries, or MEDA subregion, and the rest, which are primarily oil-exporting economies and several of which are also in the high-income GCC grouping.[7] While the two subregions exhibit very similar levels of private credit, the

[7] The MEDA group is comprised of Algeria, Egypt, Jordan, Lebanon, Libya, Morocco, Syria, Tunisia, and the West Bank and Gaza, while the rest of the region, or non-MEDA includes the GCC countries (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates), as well Djibouti, Iran, Iraq, Mauritania, and Sudan. Note that, due to data limitations, not all of the countries listed here will be included the regressions. Another subdivision used is between the six GCC and the remaining, non-GCC countries.

MEDA group is visibly lagging in stock market depth, with a turnover of about half than that observed in the rest of the MENA region. On a country by country level, Bahrain, Jordan, Lebanon, Morocco, Tunisia, and the United Arab Emirates exhibit markedly deeper banking systems, with depth well above 50 percent of GDP, while others, such as Algeria, Libya and Syria, register depth below 15 percent of GDP (Figure 2.2b). With regard to equity markets, some GCC countries stand out as having a high level of activityin particular, Saudi Arabia, with a turnover ratio of more than 130 percentwhile Jordan, Egypt and Morocco are at about 30 percent, with the rest of the countries well below the EDC average.

The second qualification is that trends in bank deepening over time are not very encouraging for a number of MENA countries. Although the region on average deepened substantially from 1970 to 2008, the MEDA subregion stalled noticeably after 2005, losing about three percentage points of GDP. At the same time, other regions such as Europe and Central Asia were able to gain ground much more rapidly, gaining close to 20 percentage points of GDP (Figure 2.3). Although banking systems in other regions may have engaged in unsustainably high rates of bank lending in the run-up to the global financial crisis, the downward movement in MEDA should be cause for some concern, at the very least to merit further study to identify factors underlying this credit slowdown.

Third, MENA countries rank lowest in terms of converting bank deposits into private sector credit. For the average MENA banking system in

2008, credit represented 69 percent of bank deposits, as opposed to 90 percent for the average EDC (Figure 2.4). In particular, the bulk of the MEDA countries fall short; on average only about half of bank deposits were converted into loans to the private sector in 2008. Furthermore, over three decades the ratio has fallen more rapidly in the MEDA countries than anywhere else, and has continued to fall over the past decade, while beginning to recover in other regions (Figure 2.4). Thus, in these countries there is substantial untapped potential in the form of deposits that could be channeled into productive activities.

2.3 Empirical Methodology

The empirical objective is to obtain efficient, unbiased, and consistent estimates of the effect of financial development on growth. The general regression model used in most studies, as well as in this paper, can be summarized as:

$$g_{it} = \alpha + \beta f_{it} + \gamma X_{it} + \delta y_{i,t-1} + c_i + \mu_t + \epsilon_{it}, \tag{2.1}$$

where $y_{i,t}$ is the GDP per capita of country i in period t and g_{it} is the growth rate of GDP per capita in the same period. The focus of the studies is on estimating β which indicates the effect of financial development, denoted by f_i, on growth. The convergence effect is denoted by δ, as lagged income, $y_{i,t-1}$(or initial income $y_{i,t0}$ in some cases) is expected to have a negative effect on growth rate. X_{it} is the set of control variables: as in Beck and Levine (2004), these include FDI and gross secondary school enrollment. Furthermore, the specification includes c_i, denoting unobserved country-specific time-invariant variable, and μ_t, the time dummy variable in period t to capture common shocks affecting all countries simultaneously. Finally, ϵ_{it} is the error term, a white noise error with mean zero.

This paper focuses on the GMM dynamic panel methodology to present econometric estimates of β, given that the OLS estimator suffers from two deficiencies. First, because of (unobserved) omitted variables that may be correlated with the included covariates and drive economic growth at the same time, OLS estimates might be biased. This arises from the possible correlation of the lagged or initial value of the dependent variable with the error term, i.e., $E[y_{i,t-1}(c_i + \epsilon_{it})] \neq 0$ or $E[y_{io}(c_i + \epsilon_{it})] \neq 0$, depending on which version of initial income is used in the regression. Second, the OLS method does not control for other sources of endogeneity such as reverse causality. Some instrumental variable estimations, such those in La Porta et al. (1998) use legal origin dummies as instruments for financial depth, but these require OLS to be applied purely at the cross-section level.

If one wishes to take advantage of time variation in the data and adopts the plausible assumption that the explanatory variables in the regression are weakly exogenousthey are affected only by the present and past levels of economic growth and uncorrelated with future innovations in growththen the GMM dynamic panel methodology proposed by Arellano and Bover (1995) and Blundell and Bond (1998) provides unbiased estimators for the coefficients of interest. The method combines a regression in levels and a regression in differences. One must be careful to apply it to cases in which the number of periods is small relative to the number of cross-sectional observations, otherwise asymptotic imprecision and biases may arise.[8] For this reason, and to smooth out cyclical variations in growth, this method is applied to non-overlapping five-year averages of the variables. Using 25 years of observations for 150 countries, the averaging produces five 5-year periods for each country, thus the number of time observations is very small relative to the number of countries.

By first-differencing Equation 2.1 we obtain the following equation which eliminates country-specific variables, thus avoiding the potential omitted variable bias caused by time-invariant heterogeneity:

$$\Delta g_{it} = \beta \Delta f_{it} + \gamma \Delta X_{it} + \delta \Delta y_{i,t-1} + \Delta \mu_t + \Delta \epsilon_{it}, \tag{2.2}$$

where $\Delta r_{it} = r_{it} - r_{i,t-1}$ for a given variable r. Although this differenced equation eliminates unobserved country-specific variables, it introduces a new correlation between the difference of lagged values of initial income and the error term (because of the correlation between $\epsilon_{i,t-1}$ in the differenced error term and the covariates). Using the weak exogeneity assumption, Arellano and Bond (1991) propose that lagged values of the weakly exogenous (predetermined) and exogenous variables be used as instruments to the differenced

[8] As noted by Roodman (2009a), a rule of thumb for avoiding over-identification of instruments is that the number of instruments be less than or equal to the number of groups in the regressions.

equation:

$$E[f_{i,t-s}\Delta\epsilon_{it}] = E[f_{i,t-s}\Delta\epsilon_{it}] = E[f_{i,t-s}\Delta\epsilon_{it}] = 0$$

$$\forall t \geq 3, s \geq 2 \ for\ weakly\ exogenous\ and\ s \geq 1\ for\ exogenous\ variables.$$

Furthermore, the Arellano and Bover method employs additional moments to be used in the GMM estimation. These are obtained from the equation for regression in levels, Equation 2.1, using the intuition that lagged differences of the covariates are valid instruments for the regression in levels and are uncorrelated with the error term under the assumption that the correlations between the country specific term, c_i, and the covariates are constant over time. For example, the lagged difference of financial development, the control variables, and lagged income, are uncorrelated with the error term and the fixed effects in Equation 2.1, i.e.:

$$E[\Delta f_{i,t-s}(c_i+\epsilon_{it})] = E[\Delta X_{i,t-s}(c_i+\epsilon_{it})] = E[\Delta y_{i,t-s}(c_i+\epsilon_{it})] = 0 \ \forall t \geq 3, s = 2.$$

Stacking all the moment conditions from the difference and level equations, a two-step GMM estimation is performed. In the first stage, it is assumed that the errors are homoskedastic and independent. The second stage takes the estimates of the variance-covariance matrix and performs a similar estimation to obtain final estimates under the assumption that the error terms are not necessarily homoskedastic and independent.[9]

[9] We use the xtabond2 command in STATA. Option h(2) is used in all regressions to control for the heteroskedasticity of the errors in the estimation of the variance-covariance matrix. Also, two lags of the covariates are used in all regressions to construct internal instrumental variables. Finally, standard errors are clustered at the country level by use of the robust option with xtabond2, as explained by Roodman (2009b).

The empirical model in this paper extends the conventional finance-growth equation to include an interaction term (Interact) between financial depth and one of three alternatives: (i) dummy variables to capture regional effects: Europe and Central Asia, MENA (or, alternatively, with MEDA or GCC subgroupings), South Asia, East Asia and Pacific, Sub-Saharan Africa, Latin America and the Caribbean, and the rest of the world (high-income countries);[10] (ii) a dummy variable for oil exporters, Oilexp, as in Nili and Rastad (2007); and (iii) the degree of oil dependence, Oildep, measured as the share of hydrocarbons in total GDP. In contrast to Oilexp, this variable varies over time as well as across countries:

$$g_{it} = \alpha + \beta f_{it} + \kappa \, Interact_i \times f_{it} + \gamma X_{it} + \delta y_{i,t-1} + c_i + \mu_t + \epsilon_{it}. \qquad (2.3)$$

We use a similar set of control variables Xi as in Beck and Levine (2004): secondary school enrollment (education) to control for the effect of the level of human capital, and FDI as a percentage of GDP. [11] All X variables are computed as the logarithm of their mean values over each five year period. κ measures the possible heterogeneity across groups of countries in the effect of financial development on economic growth. Finally, regressions are run with

[10]These dummy variables are defined according to the World Bank regional classifications for low- and middle-income countries, with one exception: the six countries of the Gulf Cooperation Council (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates) are classified here as MENA countries, whereas the World Bank classifies them as high-income countries.

[11]Here we report only the specifications including private credit as the banking depth variable and stock market turnover as the market depth variable. The main results of other specifications are essentially the same, and are available from the authors upon request.

either total real GDP per capita or real non-oil GDP per capita as dependent variables.

The present paper introduces the following methodological and data improvements over previous studies: (i) in contrast to the Becks (2011) analysis of resource-rich economies, it uses a dynamic panel method (as in Nili and Rastad, 2007) rather than cross-country regressions to uncover differences for oil exporters; (ii) in contrast to the Nili and Rastad study of oil exporters, it uses a longer and more updated sample (19752005 vs. 19922001) and takes non-overlapping five-year averages of all variables, rather than annual observations; (iii) also in contrast to Nili and Rastad, it includes a more comprehensive country sample, with up to 146 countries included in some regressions. In particular, the sample of oil exporters has been expanded,[12] and they are captured in the regressions not only through a dummy variable, but also in terms of a continuous variable measuring the degree of dependence on oil (as in Becks measures of resource dependence); (iv) in contrast to both of the above studies, it runs regressions for non-oil GDP in addition to total GDP growth. As economic diversification is a major issue for oil-dependent economies, the impact finance has on the long-run performance of the non-oil sector is of paramount importance; and (v) also in contrast to both studies, it not only examines the impact of the banking sector, but also that of stock market activity.

[12]Nili and Rastad (2007) include only twelve countries as oil exporters. This paper expands the sample to include 30 oil exporters, some of which Nili and Rastad had incorrectly classified as non-oil countries.

2.4 Regression Results

2.4.1 Banking Depth

The results of the system GMM estimator for the relationship between banking sector depthas measured by the private credit-GDP ratioand growth are shown in Tables 2.8, 2.9, and 2.10. Specifically, we examine heterogeneity in this relationship across regions (Table 2.8), between oil exporters and other countries (Table 2.9), and across income levels (Table 2.10). In the first two cases, we run regressions for growth in non-oil as well as total per capita real GDP. In Table 2.8, the first and fifth columns present the baseline specification commonly used in the literature (such as in Beck and Levine (2004) or Beck (2008)), with one key modification: we also account for the possible effect of financial crises on the finance-growth relationship. As shown by Rousseau and Wachtel (2011), the empirical link between finance and growth weakens considerably once post-1990 data are introduced, primarily as a result of the proliferation of financial crises and their adverse effects on economic activity. Indeed, using the Laeven and Valencia (2012) definition of systemic banking crises, about 60 percent of all such episodes experienced during the 19702007 period occurred in the 1990s. Furthermore, to the extent that the incidence of crises varies across countries, accounting for these episodes is also crucial to disentangle cross-country differences in the growth impact of financial deepening.[13] Across all specifications, financial crises reduce the growth impact of

[13]The Middle East and North African countries have had a particularly low incidence of these episodes: over the 19702010 period, systemic banking crises arose about 13 percent

private credit by about one-half.

The second and sixth columns in Table 2.8 report the previous results interacting private credit with the region dummy variables,[14] showing that the growth effects are lower for the MENA region, as well as for Latin America and the Caribbean. With regard to total GDP growth, the results indicate that the same level of banking depth in the MENA region produces growth effects that are about one-third smaller than in other regions. When non-oil growth is considered, the MENA region appears to fare even worse, with a growth impact about one-half that of the rest of the world. In addition, there is evidence that Europe and Central Asia obtain relatively greater growth benefits benefit from private credit. Note that, by controlling for financial crises, the estimated heterogeneity refers to growth effects across regions during normal times.

Owing to the aforementioned heterogeneity within MENA, columns (3), (4), (7), and (8) introduce regional dummies once again, but distinguish further within MENA, following two alternative subgroupings: Mediterranean-Associated countries vs. the rest; and GCC vs. the rest. The results suggest that the GCC countries behave similarly to high-income countries;[15] the co-

of the time, compared to 23 percent on average for emerging and developing economies. Furthermore, during 200010, while this frequency spiked at 60 percent for OECD countries, the MENA region managed to avoid these episodes altogether.

[14]Since the regional classification is applied to emerging and developing countries only, the null hypothesis being tested is that the coefficient on private credit in each region is equal to that in high-income countries. Therefore, significance of the coefficient of a given dummy variable indicates that, in the corresponding region, the growth impact of private credit is significantly different from that in a high-income country.

[15]Recall that in the conventional classification, the GCC countries are in fact classified as high-income countries.

efficient on the interaction term between private credit and the GCC dummy is not statistically significantly different from zero. Furthermore, when the GCC countries are combined with a set of non-Mediterranean countries, the results are similar; the MEDA interaction coefficient with private credit is negative and significant, whereas the corresponding coefficient for other MENA countries is not statistically significant.[16] Finally, once the GCC countries are accounted for separately, the interaction term for the Latin America and Caribbean region no longer becomes significant. That is, this region behaves relatively similarly to the full set of high-income countries.

In the lower portion of Tables 2.8, 2.9, and 2.10, we report results of the Arellano-Bond test for autocorrelation and the Hansen test for over-identifying restrictions. The existence of autocorrelation would indicate that lags of the covariates used as instruments are actually endogenous, and therefore, not good instruments for the regressions. The test for autocorrelation, essentially an $AR(2)$ test,[17] yields no evidence of significant autocorrelation among the set of instruments. The Hansen test checks the correlation between the residuals and exogenous variables to assess the validity of instruments.[18] The results

[16] A similar, and somewhat stronger, result occurs when distinguishing between the GCC and all non-GCC countries in the region, that is, MEDA plus Iran, Iraq, Sudan, and Yemen. The interaction coefficient for the GCC is not significant, while that of the non-GCC is negative and highly significant.

[17] The test is applied to the differenced residuals. As expected, we observe first degree correlation in differences, $AR(1)$, for all the regressions. This is because by construction $\Delta\epsilon_{it} = \epsilon_{it} - \epsilon_{i,t-1}$ should be correlated with $\Delta\epsilon_{i,t-1} = \epsilon_{i,t-1} - \epsilon_{i,t-2}$, as both include the $\epsilon_{i,t-1}$ term. To test for correlation between $\epsilon_{i,t-1}$ and $\epsilon_{i,t-2}$, we should check for the second degree correlation, $AR(2)$, in differences - since the former error term appears only in $\Delta\epsilon_{it}$ and the latter is present in $\Delta\epsilon_{i,t-2}$.

[18] Since the number of moment conditions is greater than the number of parameters to

for our regressions indicate that the null hypothesis that the instruments are exogenous cannot be rejected.

In quantitative terms, the estimation results imply that the differences in growth potential across regions are not only statistically significant, but economically meaningful as well. Figure 2.5 shows the estimated impact on long-term total GDP growth from increasing banking sector depth. As one would expect from a log specification, greater growth benefits accrue to countries that begin their deepening from a lower initial level. In Figure 2.5a, countries are shown in which the current ratio of private credit to GDP is below the EDC, and therefore the figure depicts the estimated increase in growth rate obtained if each country were to reach the EDC average. Relative to countries outside the region, MENA countries would obtain a smaller increase in growth, with the difference amounting to a quality effect of their financial depth. For example, if Algeria were to increase its current depth from an initial level of 10 percent to the EDC average of 29 percent, its growth rate is estimated to increase by 112 basis points. However, a non-MENA country starting from the same initial depth could expect to increase its growth rate by 163 basis points, thus resulting in a quality effect of 51 basis points. Several non-MENA countries are shown for comparison purposes. For example, Armenia, which would obtain a full benefit of 160 basis points if it were to reach the EDC average depth. Figure 2.5a shows a group of MENA countries with ini-

be estimated, the model is over-identified. Therefore, the test checks for the joint validity of all instruments, Z, under the null, and evaluates $E[Z\epsilon_{it}]$ to examines if it is randomly distributed around zero.

tial depth above the EDC average, therefore the figure displays the gains that would result from increasing depth by 20 percentage points of GDP, roughly the increase observed in high-income countries from 1995 to 2005. As before, for each MENA country there is the predicted effect and that which would accrue to a non-MENA country, with the difference corresponding to a quality effect.

Table 2.9 presents the results of regressions which distinguish oil exporters from the rest, confirming the Nili and Rastad finding that oil dependency weakens the finance-growth link, and thus providing evidence of a finance channel for the resource-curse. Oil exporters as a group obtain a smaller benefit from financial deepening, and the benefits fall continuously with the degree of oil dependence. Interestingly, both interaction terms are larger in absolute values in the regressions for non-oil GDP growth, thus indicating that banks in these countries have been particularly ineffective in generating productive activity outside the oil sector. Columns (3), (4), (7) and (8) present further interactions of private credit and Oilexp and Oildep with the GCC dummy. The results indicate that the GCC countries would tend to fare better in comparison to similarly oil-dependent countries outside the region. For example, Saudi Arabiawith an oil dependence of about 33 percent in 2005would obtain a greater growth benefit from private credit than would a similarly oil-dependent country, such as Trinidad and Tobago. This result is consistent with the previous result that the growth benefits from banking depth in GCC countries are similar to those in high-income countries. As a quantitative example, consider Nigeria (an African oil exporter), with average ratio of oil GDP to total GDP equal to 42% over the 2000-2005 period. The differential impact of financial depth on non-oil growth in this country for a 10% increase in private credit relative to that in a non-oil exporter will be equal to $0.044 \times 42\% \times 10\% = 18.5 basispoints$.

In Table 2.10 we summarize the findings on heterogeneity across income levels. There is evidence that LICs as a group obtain lower growth benefits from the same level of private credit, and that these benefits increase continuously with income level. Differentiating further, it is apparent that banking systems are more conducive to long-term growth in LICs which are more open to tradeas measured by the ratio of exports and imports to GDP[19]and where bank supervision is of higher quality[20]. In addition, these two characteristics only appear to affect the growth benefits of private credit in LICs, as the interaction terms for non-LICs are not statistically significant.

In Figures 2.6, 2.7, and 2.8 we show the magnitudes of the above effects; how the growth impacts of banking depth vary across income levels and with respect to openness and the quality of bank supervision. In Figure 2.6 we see that at very low income levels the growth impact is not statistically significant,

[19]We also tested for heterogeneity across income levels using the liquid liabilities-GDP and the deposits-GDP ratios. Although most results were similar, a significant mitigating effect of openness only arose in the case of private credit-GDP.

[20]The banking supervision variable is obtained from Abiad et al. (2010), and, as mentioned above, is scaled from 1 to 3. Its level depends on the degree to which the country has adopted risk-based capital adequacy ratios based on the Basel I Accord; the supervisor is independent from the executive and has sufficient legal powers; supervision covers a wide range of institutions; and on- and offsite examinations of banks are effective.

and only becomes positive (at a 95 percent confidence level) at a per capita income of \$810, or roughly the 73rd percentile for LICs in 2008[21]. Figure 2.7 illustrates the mitigating effect of the quality of bank supervision; at low levels, LICs are at a clear disadvantage, but as this quality improves, the growth impact LICs begins to approximate that of middle and high-income countries. As of 2005, the average value of the bank supervision indicator for a sample of 18 LICs s indicator was 1.4, compared to 1.8 for middle-income countries and over 2.5 for high-income countries. Finally, in Figure 2.8 we show how the lower growth impact of private credit in LICs is mitigated by the degree of trade openness of these countries. LIC banking performance begins to approximate that of other countries once total trade approaches 56 percent of GDP, or at the 47th percentile for LICs in 2008.

2.4.2 Stock Market Activity

Tables 2.11, 2.12, and 2.13 repeat the same exercises as in Tables 2.8, 2.9, and 2.10, respectively, including a stock market-based, Turnover,[22] rather than a bank-based measure of financial development as the relevant explanatory variable. As in the case of private credit, we account for banking crises

[21]Note that this figure expresses the horizontal axis in log form (as estimated in the regressions), and therefore an exponential transformation is required to translate the thresholds from the plot into income levels. Also, the levels at which the marginal growth impact of financial depth becomes nonnegative and positive are evaluated using the 95 percent confidence bands as shown. These confidence bands were constructed using the Fieller method, as described in Hirschberg and Lye (2010).

[22]As in the case with banking sector depth, we ran alternative regressions (not reported here) using the ratio of stock market capitalization to GDP as the relevant market depth variable. The results are consistent with those using stock market turnover.

and find that the coefficient on stock market turnover is positive and significant in normal times, while crises have a significant negative impact on the coefficient. However, virtually none of the cross-region heterogeneity observed for banks is present in the regressions for stock market activity, aside from weak evidence of a slightly larger growth impact in Europe and Central Asia (Table 2.11). Thus, it appears that greater deepening should be expected to generate roughly the same benefits across. The same can be said for oil exporters; neither the interaction with the oil exporter dummy nor with the degree of oil dependence yield significant coefficients, although there is weak evidence that oil exporters outside of the GCC might derive greater growth benefits from stock market activity (Table 2.12, fourth column). Regarding differences across income levels, there is also evidence that LICs obtain less growth benefits from stock market activity, an effect which is mitigated by a having higher quality bank supervision (Table 2.13, fifth column).

Figure 2.9 shows the magnitude of the potential gains across all regions from increasing stock market turnover by 20 percentage points, approximately equivalent to the deepening experienced by EDCs on average from 1995 to 2008. Starting at 10 percent, the gains are close to one-half of a percentage point, and decline to about one-fifth of a percentage point for countries starting at a turnover ratio of 30 percent.

2.5 Concluding Remarks

The positive impact of financial development on growth has been a robust empirical result in the literature for some time now. Different econometric methodologies have been developed by researchers to obtain unbiased estimates of the effect of finance on growth. This paper employs a commonly-used GMM dynamic panel methodology to investigate whether the strength of the estimated effect varies across countries.

We find that the finance-growth nexus is indeed heterogeneous across regions, income levels and between oil and non-oil exporters, and this heterogeneity arises primarily for the level of banking depth rather than for stock market activity. These general results thus give rise to another question: what specific factors drive this heterogeneity? What characteristics of banking systems might explain why some groups of countries derive greater growth benefits from the same level of activity?

Although by no means definitive, one possibility is that differences in access to financial services and in the degree of banking competitionwhich are not perfectly correlated with banking depthmight help to explain the heterogeneity. Figure 2.10 shows the performance of MENA countries relative to the EDC average and to sub-Saharan Africa, along the following dimensions: (i) banking depth, measured by private credit-GDP, (ii) use of banking services, measured by the number of bank depositors and borrowers as a share of the adult population; (iii) banking competition, measured by the H-statistic, estimated on an individual country basis by Anzoategui et al. (2010);[23] and (iv) access to banking services as reflected in enterprise surveys which ask whether firms perceive lack of financing to be a major impediment to firm growth; and (v) access measured by the percentage of surveyed firms that are receiving bank financing.

The main message to draw from these comparisons is that in MENA countries the overall volume of bank creditused in this paper as the basic measure of banking sector depthis not matched by performance in providing access to a broad segment of households and firms, or in terms of competition or efficiency of the banking system. Therefore, it seems plausible that the quality gap observed from the regression results is related to deficiencies in providing access and generating competition. As discussed earlier, the average MENA country mobilizes a larger volume of private sector credit than does the average EDC, about 30 percent greater. However, outreach of banking services to the population is visibly inferior, about 2030 percent lower, while the proportion of firms citing credit as a constraint is 10 percent higher, and the percentage of firms receiving bank financing is only four fifths of that in the average EDC. Furthermore, estimated competition in the banking system is 20 percent lower[24].

[23]The H-Statistic is an estimate of the responsiveness of bank output prices to changes in input prices. The closer the indicator is to unity, the more the price behavior resembles that of a perfectly competitive market, and therefore a higher level is interpreted as that of a more competitive market. See Anzoategui et al. (2010) for details.

[24]Anzoategui et al. (2010) find that the difference in banking competition between the MENA and other regions is statistically significant.

The relative performance of MENA countries with respect to the most financially underdeveloped region, sub-Saharan Africa, is also illuminating. Despite the fact that MENA depth is over 2? times the average in sub-Saharan Africa, outreach to borrowers is only twice as large, the share of firms indicating credit as a major constraint only 20 percent lower, and the percentage of surveyed firms receiving bank credit only 20 percent greater. Furthermore, average estimated competition in the banking system is virtually identical.

With this backdrop, the regression results show that MENA countries suffer from what is termed a quality gap in banking intermediation; for the same level of depth, the growth benefits are at most two-thirds of those obtained in other regions. As the regression results showed, this gap appears to be more pronounced for the non-GCC countries.

The finance-growth nexus tells us a similar story about LICs, with the added complication that they suffer from shallow financial systems as well. In fact, the differences in access to financial services between LICs and other countries are strikingly larger than the respective differences in depth. For example, while in 2008 banking depth in the average high-income country was 4? times the level of the average LIC, access to bank branches and ATMs was over 50 times as great, the coverage of banking services (deposits and loans) among the population was about 7 times as great, and that of non-bank institutions was 69 times as great (Figure 2.11).

Figure 2.12 summarizes the simple relationship between financial access, use of financial services, and financial depth, comparing across LICs vs.

non-LICs, oil exporters vs. others, and MENA vs. other regions. While there is a visible positive cross-country relationship between depth and access, it is noticeable that the three groups that were identified as having subpar growth benefits from depth also tend to underperform in terms of access. For the same level of depth, LICs, those in the MENA region, and oil dependent economies have considerably fewer borrowers from commercial banks and fewer branches relative to other countries.

Differences in bank ownership may also play a role. As Figure 2.13 shows, many countries in the MENA region are characterized by a relatively high share of state banks and/or a relatively small share of foreign-owned banks. However, there is also considerable heterogeneity within this group of countries. On one extreme, Algeria, Libya and Syria have a dominant role played by state banksin 2008, the asset shares approached 100 percent in the first two, and about 70 percent in the latterand essentially no entry of foreign banks. At the other extreme, Lebanon and Jordan have zero state bank participation, while having permitted substantial foreign bank penetration. The remaining countries lie somewhere in between, with state bank participation that is high by international standardsbetween 37 and 57 percent market share in 2008and with modest foreign bank participation, below international averages.

What are the consequences of having relatively high state bank participation and low foreign bank participation? Regarding state banks, their strong presence has often been cited as a factor limiting financial development, yet the question of whether they exert an independent negative impact on growthfor example, via a lower quality of bank intermediationis not clear-cut. However, a recent study by Korner and Schnabel (2010) identified two factors that combine to produce significant negative growth effects from state ownership of banks: low levels of financial depth and low institutional quality[25]. Within the country sample analyzed, several MENA countriesBahrain, Egypt, Kuwait, and Syriafell in the group for which state ownership was likely to undermine growth. Furthermore, there is country-level evidence of inefficiency and corruption in lending by state-owned banks. For example, Khwaja and Mian (2005) document the preferential treatment given exclusively by state-owned banks to politically connected firms in Pakistan, amounting to a distribution of political rents which cost the aggregate economy up to an estimated 1.9 percent of GDP per year. Foreign bank presence, on the other hand, has often been linked to improvements in banking sector performance and competition, thus suggesting potential benefits that could accrue from allowing greater openness to these institutions.

Of course, the weaker link between finance and economic growth in certain groups of countries could also be due to weakness on the demand side of the credit market, that is, to a lack of profitable investment opportunities. In the case of oil exporters, it is certainly plausible that, due to Dutch Disease-type effects, non-oil sectors are simply not competitive and therefore yield

[25]This study analyzed the impact of state banks on economic growth during 1970-2007. The institutional variables considered were: democracy, political rights, bureaucracy quality, and corruption control.

lower returns than their counterparts in the rest of the world. Our regression results with non-oil growth as the dependent variable would be consistent with this interpretation. However, it is not clear why other, non-oil exporting MENA countries or LICs would have systematically lower returns on bank-financed investments, as our results would imply. Finally, if the source of weakness is on the demand side, then it is not clear why the weaker finance-growth nexus does not extend to stock markets as well. Therefore, our reading of the results is that it is primarily conditions on the supply sidethe functioning of banks and their regulatory environmentthat are driving the weaker growth outcomes in MENA, oil exporters, and LICs.

Thus, policymakers in these countries are faced with a complex challenge. In addition to establishing and consolidating macroeconomic stability, and continuing with financial reform, both of which will provide the basis for greater financial deepening both in banking and stock markets, efforts must be made on two additional fronts. First, impediments to credit expansion must be reduced, especially in MENA countries, to increase the amount of credit per unit of deposits. The most likely suspects are fiscal dominance or overly restrictive monetary policy, both of which might be diverting bank funds away from financing the private sector. Second, policymakers should also pursue actions that enhance the quality of bank intermediationpossibly including a reassessment of the role of state bankswhich should lead to improvements in access and greater competition. As discussed extensively and convincingly in the recent World Bank flagship report on finance in the MENA region (World

Bank, 2011), introducing improvements in information on prospective borrowersincluding the establishment of credit bureaus enhancing the legal protection of creditor rights as well as the framework surrounding secured transactions, are all potential areas where quality gains can be achieved. For LICs, improvements in bank supervision should be pursued as well. Ultimately, these actions should result in benefits in terms of higher and more sustainable long-run growth.

2.6 Appendix: Country List by Region (150 countries)

(Oil dependent and low income countries are marked by * and °, respectively)

East Asia & Pacific

Cambodia°
Fiji
Indonesia*
Lao PDR°
Malaysia*
Mongolia°
Papua New Guinea*°
Philippines
Samoa°
Solomon Islands°
Thailand
Tonga°
Vanuatu°
Vietnam°

Europe & Central Asia

Albania
Armenia°
Bulgaria
Georgia°
Kazakhstan*
Lithuania
Moldova°
Romania
Russian Federation*
Serbia
Turkey
Ukraine
Uzbekistan*°

Latin America & Caribbean

Argentina
Belize
Bolivia*°
Brazil
Chile
Colombia
Costa Rica
Dominica
Dominican Republic°
Ecuador*
El Salvador
Grenada°
Guatemala
Guyana°
Haiti°
Honduras°
Jamaica
Mexico*
Panama
Paraguay
Peru
St. Kitts and Nevis
St. Lucia°
St. Vincent & Grenadines°
Uruguay
Venezuela, RB*

Middle East & North Africa

Algeria*
Bahrain*
Egypt, Arab Rep.*
Iran, Islamic Rep.*
Jordan
Kuwait*
Lebanon
Libya*
Morocco
Oman*
Qatar*
Saudi Arabia*
Sudan*°
Syrian Arab Republic*
Tunisia*
United Arab Emirates*
Yemen*°

South Asia

Bangladesh°
Bhutan°
India
Nepal°
Pakistan
Sri Lanka

Sub-Saharan Africa

Angola*
Benin°
Botswana
Burkina Faso°
Burundi°
Cameroon*°
Cape Verde°
Central African Republic°
Chad*°
Congo, Republic of*°
Cote d'Ivoire°
Ethiopia°
Gabon*
Gambia°
Ghana°
Kenya°
Lesotho°
Madagascar°
Malawi°
Mali°
Mauritania°
Mauritius
Mozambique°
Namibia
Niger°
Nigeria*°
Rwanda°
Senegal°
South Africa
Swaziland
Tanzania°
Togo°
Uganda°
Zambia°
Zimbabwe

High-Income Countries

Bahamas, The
Barbados
Belgium
Brunei Darussalam
Canada*
Croatia
Cyprus
Czech Republic
Denmark
Equatorial Guinea*
Estonia
Germany
Greece
Hungary
Iceland
Ireland
Israel
Italy
Japan
Korea, Rep.
Latvia
Malta
Norway*
Poland
Portugal
Slovak Republic
Slovenia
Spain
Sweden
Switzerland
Trinidad and Tobago*
United Kingdom
United States

Table 2.1: Summary Statistics

	Number of Observations	Mean	Std. Dev.	Min	Max
Private Credit	673	35.951	31.042	0.456	191.697
Bank Deposits	668	38.352	29.249	1.828	216.983
Liquid Liabilities	655	44.22	28.497	5.212	227.672
Market Cap	357	32.217	38.473	0.038	232.213
Turnover	361	33.487	41.633	0.144	294.096
Growth	696	1.737	2.852	-9.838	9.998
Non-Oil Growth	645	1.749	2.923	-10.929	9.86
Education	671	61.825	32.998	2.499	158.453
FDI	696	2.48	3.46	-3.623	33.54
Oil	652	0.04	0.121	0	0.78
Lerner Index	315	0.242	0.096	-0.034	0.501
H-Stat	309	0.653	0.185	0.174	1.035

Table 2.2: Cross-Country Summary Statistics

	Number of Countries	Mean	Std. Dev.	Min	Max
Private Credit	146	33.753	26.735	2.857	148.269
Bank Deposits	144	36.713	26.439	4.595	173.864
Liquid Liabilities	142	42.783	26.072	9.591	182.613
Market Cap	105	29.916	33.343	0.547	156.721
Turnover	104	29.761	29.526	0.742	139.587
Growth	150	1.894	1.673	-1.769	7.997
Non-Oil Growth	147	1.886	1.842	-3.747	7.997
Education	150	62.544	31.308	5.638	115.638
FDI	150	2.835	2.817	0.06	16.406
Oil	147	0.056	0.144	0	0.757
Lerner Index	70	0.249	0.096	-0.034	0.501
H-Stat	69	0.635	0.185	0.174	1.035

Table 2.3: Summary Statistics - Oil Exporters

	Number of Observations	Mean	Std. Dev.	Min	Max
Private Credit	136	26.347	21.558	2.004	136.846
Bank Deposits	131	30.526	22.08	2.08	115.104
Liquid Liabilities	132	39.024	23.869	5.212	123.68
Market Cap	70	31.157	41.278	0.038	198.713
Turnover	70	21.639	23.446	0.144	100.875
Growth	137	1.28	3.144	-9.838	9.998
Non-Oil Growth	97	1.153	3.735	-10.929	9.847
Education	131	55.128	26.991	6.043	117.992
FDI	137	2.496	3.537	-3.073	28.225
Oil	104	0.25	0.197	0	0.78
Lerner Index	88	0.301	0.113	0.063	0.501
H-Stat	88	0.643	0.161	0.299	0.991

Table 2.4: Cross-Country Summary Statistics - Oil Exporters

	Number of Countries	Mean	Std. Dev.	Min	Max
Private Credit	31	24.896	17.916	2.857	88.68
Bank Deposits	30	29.241	20.258	4.764	92.135
Liquid Liabilities	30	37.533	21.493	12.796	101.873
Market Cap	19	37.261	40.727	6.892	146.005
Turnover	19	21.705	20.291	0.839	67.584
Growth	31	1.432	1.536	-1.278	5.473
Non-Oil Growth	31	1.37	2.259	-3.747	6.212
Education	31	56.913	27.417	8.862	106.619
FDI	31	3.235	3.72	0.115	16.406
Oil	31	0.265	0.21	0.031	0.757
Lerner Index	19	0.32	0.116	0.063	0.501
H-Stat	19	0.62	0.168	0.299	0.991

Table 2.5: Sample Means by Region

	I	II	III	IV	V	VI	VII	VIII	IX
Private Credit	31.47	31.15	13.84	32.52	18.49	15.00	60.34	17.52	29.78
Bank Deposits	39.19	36.87	17.44	36.85	27.88	18.20	58.07	22.57	33.73
Liquid Liabilities	51.40	43.01	24.31	42.62	35.54	25.27	61.61	29.92	41.09
Market Cap	46.14	27.80	8.32	17.40	10.16	21.49	45.73	7.97	21.71
Turnover	21.20	26.18	27.73	10.6	46.91	5.275	50.71	11.50	18.71
Growth	1.37	2.55	2.92	1.667	3.26	1.044	2.25	1.65	2.04
Non-Oil Growth	1.97	2.27	3.17	1.71	3.26	0.97	2.085	1.53	2.12
Education	66.54	49.85	85.84	63.34	38.40	25.501	94.02	36.32	66.54
FDI	2.13	3.04	3.19	3.75	0.44	2.51	3.00	2.97	2.74
Oil	0.24	0.02	0.01	0.02	0.00	0.08	0.02	0.03	0.07
Lerner Index	0.35	0.26	0.24	0.19	0.25	0.24	0.24	0.25	0.23
H-Stat	0.53	0.74	0.61	0.76	0.72	0.53	0.64	0.56	0.68

Notes: Region I is Middle East and North Africa, Region II is East Asia and the Pacific, Region III is Europe and Central Asia, Region IV is Latin America and the Caribbean, Region V is South Asia, Region VI is Sub-Saharan Africa, and Region VII includes the rest of the world. Furthermore, Column VIII includes low income countries, and column IX provides sample means for middle income countries.

Table 2.6: Tests for Differences in Means (p-values)

	Non-oil Exporters vs. Oil Exporters	Other Regions vs. MENA	Other Regions vs. LICs	High Income vs. LICs
Private Credit	0.0195	0.329	0	0
Bank Deposits	0.0426	0.4485	0	0
Liquid Liabilities	0.11	0.1464	0	0
Market Cap	0.1444	0.0366	0.0003	0
Turnover	0.117	0.1438	0.0012	0
Growth	0.0406	0.0577	0.0902	0.1627
Non-Oil Growth	0.0395	0.4994	0.0403	0.1162
Education	0.159	0.428	0	0
FDI	0.2099	0.2075	0.3365	0.4154

Table 2.7: Unconditional Correlations - Full Sample of Countries

Pairwise Correlation - One observation per country

	Private Credit	Bank Deposits	Liquid Liabilities	Market Cap	Turnover	Growth	Non-Oil Growth
Private Credit	1						
	146						
Bank Deposits	0.8909*	1					
	144	144					
Liquid Liabilities	0.8567*	0.9856*	1				
	142	142	142				
Market Cap	0.6135*	0.5826*	0.5870*	1			
	101	99	97	105			
Turnover	0.4539*	0.3450*	0.3528*	0.3484*	1		
	100	98	96	103	104		
Growth	0.1413	0.1744*	0.1230	-0.0581	0.2143*	1	
	146	144	142	105	104	150	
Non-Oil Growth	0.1501	0.1887*	0.1413	0.0082	0.1625	0.8996*	1
	144	142	140	102	101	147	147

Pairwise Correlation - 5 year averages

	Private Credit	Bank Deposits	Liquid Liabilities	Market Cap	Turnover	Growth	Non-Oil Growth
Private Credit	1						
	673						
Bank Deposits	0.8697*	1					
	666	668					
Liquid Liabilities	0.8343*	0.9856*	1				
	652	654	655				
Market Cap	0.5899*	0.5337*	0.5463*	1			
	335	331	325	357			
Turnover	0.3083*	0.2275*	0.2349*	0.3025*	1		
	338	334	328	351	361		
Growth	0.0884*	0.1245*	0.0972*	0.0526	0.0842	1	
	673	668	655	357	361	696	
Non-Oil Growth	0.0775	0.1157*	0.0907*	0.0252	0.0942	0.9480*	1
	625	620	606	333	337	645	645

Table 2.8: Private Credit and Growth: Heterogeneity across Regions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Dependent variable: Real per capita GDP growth				Dependent variable: Real per capita non-oil GDP growth			
Private Credit	0.013 ***	0.016 **	0.012 *	0.015 **	0.012 ***	0.018 **	0.014 **	0.012
	(-3.473)	(2.342)	(1.960)	(2.255)	(2.658)	(2.083)	(2.464)	(1.491)
Private Credit x Financial Crisis	-0.006 ***	-0.005 ***	-0.006 ***	-0.006 ***	-0.007 ***	-0.005 ***	-0.006 ***	-0.006 **
	(-5.624)	(-2.670)	(-4.012)	(-2.954)	(-6.022)	(-2.651)	(-2.688)	(-2.602)
Interactions with region dummies								
Private Credit x Middle East and North Africa		-0.005 *				-0.009 ***		
		(-1.765)				(-2.679)		
Subgrouping 1								
Private Credit x MEDA			-0.007 *				-0.008 *	
			(-1.732)				(-1.879)	
Private Credit x non-MEDA			-0.001				0.000	
			(-0.364)				(-0.071)	
Subgrouping 2								
Private Credit x GCC				0.002				0.004
				(0.837)				(1.138)
Private Credit x non-GCC				-0.012 **				-0.009 *
				(-2.018)				(-1.730)
Private Credit x East Asia & Pacific		-0.002	0.000	-0.003		-0.004	-0.002	-0.003
		(-0.389)	(-0.089)	(-0.621)		(-0.636)	(-0.326)	(-0.330)
Private Credit x Europe & Central Asia		0.011 **	0.014 **	0.011 *		0.009	0.014 **	0.010
		(2.043)	(2.425)	(1.734)		(1.457)	(2.174)	(1.566)
Private Credit x Latin American & Caribbean		-0.006 *	-0.004	-0.006		-0.007 *	-0.004	-0.005
		(-1.783)	(-1.181)	(-1.422)		(-1.928)	(-1.007)	(-1.165)
Private Credit x South Asia		-0.008	-0.004	-0.007		-0.009	-0.004	-0.006
		(-1.420)	(-0.734)	(-1.121)		(-1.298)	(-0.565)	(-0.805)
Private Credit x Sub-Saharan Africa		-0.008	-0.005	-0.010		-0.007	-0.004	-0.006
		(-1.418)	(-0.911)	(-1.491)		(-0.981)	(-0.656)	(-0.835)
Controls								
Education	0.021 **	0.022 **	0.017 **	0.018 *	0.018 *	0.026 **	0.018 *	0.021 **
	(2.486)	(2.561)	(2.036)	(1.878)	(1.780)	(2.612)	(1.914)	(2.353)
Initial GDP per capita	-0.015 ***	-0.021 ***	-0.016 **	-0.020 ***	-0.013 ***	-0.023 ***	-0.016 **	-0.018 **
	(-3.270)	(-3.473)	(-2.488)	(-2.636)	(-2.620)	(-2.890)	(-2.382)	(-2.321)
Terms of Trade	0.354 ***			0.263 **				
	(3.198)			(2.210)				
FDI	0.348 ***	0.234 *	0.238 *	0.223 *	0.261 ***	0.138	0.156	0.205
	(3.319)	(1.847)	(1.879)	(1.804)	(2.617)	(1.037)	(1.105)	(1.486)
Government consumption	-1.630 ***			-1.156 **				
	(-3.197)			(-2.067)				
Constant	-1.603 ***		-1.060 *	-0.964 *	-1.194 **	-0.594	-0.684	-0.904
	(-3.321)		(-1.790)	(-1.678)	(-2.592)	(-0.945)	(-1.050)	(-1.398)
Observations	678		678	678	630	619	630	630
Number of countries	146		146	146	144	140	144	144
AR2	0.927		0.991	0.966	0.968	0.866	0.984	0.965
Hansen	0.300		0.419	0.273	0.140	0.480	0.340	0.479
Number of instruments	76		100	100	76	92	100	100
Wald test statistic for significance of coefficient of Private Credit in certain regions			0.141	0.433			0.070	0.62
Wald Test is for the sum of coefficients on Private Credit and its Interaction with:			MEDA	non-GCC			MEDA	non-GCC

This table shows the results of dynamic panel regressions for growth of real total anf non-oil per capita GDP using a GMM procedure following Arellano and Bover(1995). The explanatory variables are Private credit, the ratio of bank credit to the private sector to GDP; Education, percentage of gross secondary school enrollment; Initial income, initial GDP per capita; and FDI expressed as a percentage of GDP. Some specifications also include interactions between private credit and regional dummy variables. Data are averaged over non-overlapping five year periods beginning in 1980. Robust t-statistics are shown in parentheses, and significance at the 1 percent (***), 5 percent (**), and 10 percent (*) levels are indicated.

Table 2.9: Private Credit and Growth: Heterogeneity between Oil Exporters and other Countries

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Dependent variable: Real per capita GDP growth				Dependent variable: Real per capita non-oil GDP growth			
Private Credit	0.011 ***	0.012 ***	0.011 ***	0.011 ***	0.010 *	0.009 **	0.010 *	0.008 *
	(3.033)	(2.810)	(2.931)	(2.824)	(1.949)	(2.179)	(1.774)	(1.822)
Private Credit x Financial Crisis	-0.006 ***	-0.006 ***	-0.006 ***	-0.006 ***	-0.006 ***	-0.006 ***	-0.006 ***	-0.006 ***
	(-5.204)	(-4.864)	(-5.445)	(-5.122)	(-4.959)	(-4.793)	(-5.428)	(-5.219)
Interactions with oil exporter variables								
Private Credit x Oilexp	-0.007 **		-0.004		-0.010 **		-0.010	
	(-2.255)		(-1.438)		(-2.126)		(-1.600)	
Private Credit x Oildep		-0.030 ***		-0.030 **		-0.044 ***		-0.044 ***
		(-3.118)		(-2.021)		(-3.777)		(-3.108)
Private Credit x Oilexp x GCC			0.001				0.003	
			(-0.227)				(0.503)	
Private Credit x Oildep x GCC				0.031 *				0.025
				(-1.903)				(-1.406)
Controls								
Education	0.017 **	0.015 *	0.017 **	0.016 *	0.015	0.011	0.013	0.012
	(2.295)	(1.950)	(2.115)	(1.913)	(1.534)	(1.193)	(1.507)	(1.290)
Initial GDP per capita	-0.012 ***	-0.013 ***	-0.012 ***	-0.012 **	-0.011 **	-0.009 *	-0.010 **	-0.008 *
	(-2.884)	(-2.863)	(-2.761)	(-2.545)	(-2.093)	(-1.848)	(-2.166)	(-1.743)
Terms of Trade		0.233 *			0.281 **			
		(1.833)			(2.532)			
FDI	0.357 ***	0.276 ***	0.341 ***	0.288 ***	0.284 ***	0.186	0.295 ***	0.208 *
	(3.025)	(2.537)	(-2.989)	(-2.795)	(2.888)	(1.652)	(3.003)	(1.964)
Government consumption		-1.011 *			-1.278 **			
		(-1.711)			(-2.467)			
Constant	-1.640 ***	-1.254 **	-1.566 ***	-1.315 ***	-1.294 ***	-0.834	-1.348 ***	-0.946 *
	(-2.997)	(-2.472)	(-2.970)	(-2.751)	(-2.838)	(-1.584)	(-2.949)	(-1.908)
Observations	678	637	678	637	630	630	630	630
Number of countries	146	144	146	144	144	144	144	144
AR2	0.832	0.928	0.880	0.928	0.969	0.946	0.950	0.929
Hansen	0.278	0.098	0.328	0.299	0.096	0.066	0.255	0.218
Number of instruments	90	90	104	101	90	90	101	100
Wald test statistic for significance of coefficient of Private Credit in certain regions	0.337	0.074	0.151	0.232	0.984	0.009	0.645	0.318
Wald Test is for the sum of coefficients on Private Credit and its Interaction with:	Oilexp	Oildep	Oilexp +	Oildep +	Oilexp	Oildep	Oilexp +	Oildep +
			Oilexp X GCC	Oildep X GCC			Oilexp X GCC	Oildep X GCC

This table shows the results of dynamic panel regressions for growth of real total and non-oil per capita GDP using a GMM procedure following Arellano and Bover(1995). The explanatory variables are: Oilexp, a dummy variable for oil exporting countries; Oildep, the share of oil GDP in total GDP; Private credit, the ratio of bank credit to the private sector to GDP; Education, percentage of gross secondary school enrollment; Initial income, initial GDP per capita; and FDI expressed as a percentage of GDP. Some specifications also include interactions between private credit and either Oilexp or Oildep. Data are averaged over non-overlapping five year periods beginning in 1980. Robust t-statistics are shown in parentheses, and significance at the 1 percent (***), 5 percent (**), and 10 percent (*) levels are indicated.

Table 2.10: Private Credit and Growth: Heterogeneity across Income Levels

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Dependent variable: Real per capita GDP growth							
Private Credit	0.017 ***	-0.047 **	0.017 ***	0.011 **	0.013 ***	0.013 **	0.019 *	0.027 **
	(2.471)	(-2.593)	(3.262)	(2.389)	(2.879)	(2.571)	(1.783)	(2.410)
Private Credit x Financial Crisis	-0.006 ***	-0.006 ***	-0.006 ***	-0.010 ***	-0.010 ***	-0.009 ***	-0.006 ***	-0.006
	(-4.046)	(-4.090)	(-3.905)	(-3.847)	(-3.303)	(-3.435)	(-4.029)	(-3.944)
Interactions with variables related to income								
Private Credit x LIC	-0.006		-0.033 ***	-0.006	-0.011 ***	-0.011 ***	-0.006 *	-0.041 ***
	(-1.483)		(-2.395)	(-1.280)	(-2.795)	(-2.929)	(-1.721)	(-2.627)
Private Credit x Income		0.009 ***						
		(3.092)						
Private Credit x Openness							-0.001	-0.003
							(-0.262)	(-1.019)
Private Credit x LIC x Openness			0.006 ***					0.009 **
			(1.867)					(2.222)
Private Credit x Bank Supervision				0.001		0.001		
				(0.493)		(0.632)		
Private Credit x LIC x Bank Supervision					0.003	0.004 *		
					(0.314)	(1.929)		
Controls								
Education	0.028 ***	0.035 ***	0.024 **	0.023 **	0.017 ***	0.019 *	0.021 **	0.019 **
	(3.142)	(5.056)	(3.118)	(2.178)	(2.259)	(1.873)	(2.609)	(2.509)
Initial GDP per capita	-0.024 ***	-0.054 ***	-0.023 ***	-0.020 ***	-0.019 ***	-0.019 ***	-0.020 ***	-0.020 ***
	(-2.673)	(-4.055)	(-3.644)	(-2.891)	(-3.362)	(-2.935)	(-3.828)	(-4.343)
Terms of Trade								
FDI	0.298 **	0.275 ***	0.362 **	0.225	0.270	0.227	0.389 ***	0.373 ***
	(2.479)	(2.653)	(2.775)	(1.089)	(1.348)	(1.138)	(2.895)	(2.633)
Government consumption								
Constant	-1.331 ***	-1.051 **	-1.625 ***	-0.993	-1.180	-1.000	-1.765 ***	-1.680 **
	(-2.347)	(-2.051)	(-2.708)	(-1.036)	(-1.270)	(-1.076)	(-2.865)	(-2.580)
Observations	678	677	652	407	407	407	652	652
Number of countries	146	146	142	80	80	80	142	142
AR2	0.920	0.812	0.985	0.492	0.492	0.467	0.882	0.926
Hansen	0.453	0.301	0.679	0.100	0.100	0.161	0.483	0.707
Number of instruments	96	96	109	63	63	71	109	122

This table shows the results of dynamic panel regressions for growth of real total per capita GDP using a GMM procedure following Arellano and Bover(1995). The explanatory variables are Private credit, the ratio of bank credit to the private sector to GDP; Education, percentage of gross secondary school enrollment; Initial income, initial GDP per capita; and FDI expressed as a percentage of GDP. Some specifications also include interactions between private credit and a Low-Income Country (LIC) dummy variables and/or either the quality of bank bupervision, (from Abiad, et al, 2008) and the degree of trade openness (ratio of exports plus imports to GDP) . Data are averaged over non-overlapping five year periods beginning in 1980. Robust t-statistics are shown in parentheses, and significance at the 1 percent (***), 5 percent (**), and 10 percent (*) levels are indicated.

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Table 2.11: Stock Market Turnover Ratio and Growth: Heterogeneity across Regions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Dependent variable: Real per capita GDP growth				Dependent variable: Real per capita non-oil GDP growth			
Turnover	0.005 **	0.009 **	0.008 **	0.009 **	0.005 **	0.007 *	0.008 **	0.008 *
	(2.472)	(2.225)	(2.218)	-2.411	(2.392)	(1.742)	(2.117)	(1.964)
Turnover x Financial Crisis	-0.006 ***	-0.010 ***	-0.010 ***	-0.009 ***	-0.009 ***	-0.012 ***	-0.013 ***	-0.012 ***
	(-4.140)	(-4.017)	(-3.945)	(-3.314)	(-4.434)	(-3.911)	(-4.098)	(-3.790)
Interactions with region dummies								
Turnover x Middle East and North Africa		-0.001				0.000		
		(-0.155)				(-0.038)		
Subgrouping 1								
Turnover x MEDA			-0.002				-0.003	
			(-0.303)				(-0.453)	
Turnover x non-MEDA			-0.001				-0.001	
			(-0.316)				(-0.079)	
Subgrouping 2								
Turnover x GCC				0.001				0.000
				(0.374)				(0.085)
Turnover x non-GCC				-0.002				-0.002
				(-0.397)				(-0.474)
Turnover x East Asia & Pacific		0.002	0.000	-0.001		0.003	0.001	0.001
		(0.463)	(0.116)	(-0.238)		(0.577)	(0.161)	(0.198)
Turnover x Europe & Central Asia		0.009	0.008	0.006		0.012 **	0.012 *	0.011 **
		(1.508)	(1.359)	(1.036)		(2.222)	(1.834)	(2.009)
Turnover x Latin American & Caribbean		-0.002	-0.002	-0.003		-0.003	-0.003	-0.003
		(-0.455)	(-0.598)	(-0.804)		(-0.612)	(-0.513)	(-0.566)
Turnover x South Asia		-0.003	-0.003	-0.004		-0.001	-0.003	-0.004
		(-0.791)	(-0.729)	(-0.959)		(-0.214)	(-0.568)	(-0.865)
Turnover x Sub-Saharan Africa		-0.005	-0.006	-0.006		0.003	0.001	0.001
		(-0.733)	(-0.926)	(-1.001)		(0.346)	(0.129)	(0.109)
Controls								
Education	0.024 **	0.008	0.006	0.009	0.024 *	0.010	0.010	0.008
	(2.263)	(0.432)	(0.387)	(0.556)	(1.887)	(0.643)	(0.666)	(0.446)
Initial GDP per capita	-0.011 ***	-0.012 **	-0.012 ***	-0.014 **	-0.013 ***	-0.010 *	-0.012 **	-0.012 **
	(-4.265)	(-2.358)	(-2.699)	(-2.408)	(-3.116)	(-1.789)	(-2.225)	(-2.095)
Terms of Trade								
FDI	0.266 *	0.405 **	0.353 *	0.333 *	0.247 *	0.243	0.247	0.285
	(1.792)	(2.056)	(1.784)	(1.781)	(1.748)	(1.073)	(1.112)	(1.448)
Government consumption								
Constant	-1.228 *	-1.805 *	-1.554 *	-1.465 *	-1.131 *	-1.078	-1.085	-1.249
	(-1.789)	(-1.969)	(-1.675)	(-1.669)	(-1.732)	(-1.021)	(-1.042)	(-1.362)
Observations	363	363	363	363	339	339	339	339
Number of countries	104	104	104	104	101	101	101	101
AR2	0.969	0.814	0.858	0.891	0.577	0.766	0.626	0.720
Hansen	0.471	0.557	0.739	0.686	0.664	0.682	0.681	0.607
Number of instruments	76	92	95	95	76	92	95	95
Wald test statistic for significance of coefficient of Turnover in certain regions		0.113	0.063	0.275		0.311	0.436	0.174
Wald Test is for the sum of coefficients on Turnover and its Interaction with:		MENA	MEDA	non-GCC		MENA	MEDA	non-GCC

This table shows the results of dynamic panel regressions for growth of real total anf non-oil per capita GDP using a GMM procedure following Arellano and Bover(1995). The explanatory variables are: Turnover, the ratio of stock market val;ue traded to GDP; Education, percentage of gross secondary school enrollment; Initial income, initial GDP per capita; and FDI expressed as a percentage of GDP. Some specifications also include interactions between Turnover and regional dummy variables. Data are averaged over non-overlapping five year periods beginning in 1980. Robust t-statistics are shown in parentheses, and significance at the 1 percent (***), 5 percent (**), and 10 percent (*) levels are indicated.

Table 2.12: Stock Market Turnover and Growth: Heterogeneity between Oil Exporters and other Countries

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Dependent variable: Real per capita GDP growth				Dependent variable: Real per capita non-oil GDP growth			
Turnover	0.004 **	0.004 *	0.004 *	0.004	0.005 **	0.005 **	0.005 **	0.005 **
	(2.299)	(1.740)	(1.804)	(1.597)	(2.026)	(2.426)	(2.150)	(2.329)
Turnover x Financial Crisis	-0.007 ***	-0.007 ***	-0.007 ***	-0.008 ***	-0.010 ***	-0.009 ***	-0.010 ***	-0.010 ***
	(-4.125)	(-3.649)	(-3.981)	(-4.222)	(-5.173)	(-5.042)	(-5.270)	(-5.203)
Interactions with oil exporter variables								
Turnover x Oilexp	0.000		0.002		-0.001		0.000	
	(-0.173)		(0.645)		(-0.386)		(-0.087)	
Turnover x Oildep		-0.006		0.015 **		-0.006		0.018
		(-0.751)		(1.996)		(-0.441)		(0.690)
Turnover x Oilexp x GCC			-0.004				-0.002	
			(-1.573)				(-0.518)	
Turnover x Oildep x GCC				-0.028 ***				-0.032
				(-2.994)				(-1.289)
Controls								
Education	0.023 ***	0.022 *	0.021 **	0.023 **	0.023 *	0.024 *	0.023 **	0.026 *
	(2.808)	(1.889)	(2.369)	(2.035)	(1.974)	(1.761)	(2.018)	(1.748)
Initial GDP per capita	-0.012 ***	-0.011 ***	-0.011 ***	-0.011 ***	-0.014 ***	-0.013 ***	-0.013 ***	-0.013 ***
	(-4.527)	(-3.580)	(-4.104)	(-2.967)	(-3.578)	(-3.241)	(-3.728)	(-3.228)
Terms of Trade								
FDI	0.277 *	0.275	0.262 *	0.253 *	0.195	0.226	0.203	0.183
	(1.781)	(1.641)	(1.810)	(1.819)	(1.462)	(1.544)	(1.504)	(1.442)
Government consumption								
Constant	-1.266 *	-1.261	-1.202 *	-1.169 *	-0.877	-1.028	-0.918	-0.836
	(-1.759)	(-1.628)	(-1.793)	(-1.809)	(-1.415)	(-1.523)	(-1.474)	(-1.415)
Observations	363	343	363	343	339	339	339	339
Number of countries	104	101	104	101	101	101	101	101
AR2	0.977	0.481	0.962	0.570	0.551	0.562	0.567	0.746
Hansen	0.753	0.610	0.728	0.759	0.710	0.605	0.672	0.737
Number of instruments	90	90	95	95	89	89	94	94
Wald test statistic for significance of coefficient of Private Credit in certain regions	0.102	0.876	0.728	0.216	0.363	0.973	0.620	0.395
Wald Test is for the sum of coefficients on Private Credit and its Interaction with:	Oilexp	Oildep	Oilexp +	Oildep +	Oilexp	Oildep	Oilexp +	Oildep +
			Oilexp X GCC	Oildep X GCC			Oilexp X GCC	Oildep X GCC

This table shows the results of dynamic panel regressions for growth of real total and non-oil per capita GDP using a GMM procedure following Arellano and Bover(1995). The explanatory variables are: Oilexp, a dummy variable for oil exporting countries; Oildep, the share of oil GDP in total GDP; Turnover, the ratio of stock market value traded to GDP; Education, percentage of gross secondary school enrollment; Initial income, initial GDP per capita; and FDI expressed as a percentage of GDP. Some specifications also include interactions between turnover and either Oilexp or Oildep. Data are averaged over non-overlapping five year periods beginning in 1980. Robust t-statistics are shown in parentheses, and significance at the 1 percent (***), 5 percent (**), and 10 percent (*) levels are indicated.

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Table 2.13: Stock Market Turnover and Growth: Heterogeneity across Income Levels

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Dependent variable: Real per capita GDP growth							
Turnover	0.007 ***	0.006	0.007 ***	0.013 ***	0.011 ***	0.012 ***	0.002	0.004
	(2.771)	(0.563)	(2.458)	(2.799)	(3.768)	(3.409)	(0.225)	(0.446)
Turnover x Financial Crisis	-0.009 ***	-0.008 ***	-0.007 ***	-0.015 ***	-0.011 ***	-0.014	-0.008 ***	-0.007 ***
	(-3.628)	(-3.374)	(-3.207)	(-4.106)	(-3.628)	(-4.371)	(-3.840)	(-2.916)
Interactions with variables related to income								
Turnover x LIC	-0.003		0.019	-0.004	-0.011 **	-0.010 *	-0.002	0.024
	(-0.884)		(0.668)	(-1.761)	(-2.463)	(-1.904)	(-0.674)	(0.930)
Turnover x Income		0.000						
		(0.066)						
Turnover x Openness							0.002	0.001
							(0.848)	(0.432)
Turnover x LIC x Openness			-0.006					-0.007
			(-0.743)					(-1.002)
Turnover x Bank Supervision				-0.001		-0.001		
				(-0.718)		(-0.910)		
Turnover x LIC x Bank Supervision					0.007 *	0.007		
					(1.970)	(1.407)		
Controls								
Education	0.009	0.012	0.012	0.022 **	0.021 **	0.019 ***	0.003	0.009
	(0.748)	(0.889)	(1.330)	(2.026)	(2.626)	(2.653)	(0.220)	(0.754)
Initial GDP per capita	-0.011 **	-0.010	-0.011 ***	-0.017 ***	-0.017 ***	-0.016 ***	-0.010 **	-0.011 ***
	(-2.187)	(-1.597)	(-3.082)	(-4.721)	(-4.889)	(-4.605)	(-2.128)	(-2.880)
Terms of Trade								
FDI	0.312 **	0.299 *	0.612 ***	0.008	0.283 *	0.296	0.533 ***	0.557 ***
	(2.008)	(1.799)	(5.396)	(1.165)	(1.727)	(1.381)	(4.734)	(5.470)
Government consumption								
Constant	-1.389 *	-1.342 *	-2.787 ***	0.000	-1.265 *	-1.327	-2.397 ***	-2.523
	(-1.931)	(-1.755)	(-5.337)	(0.000)	(-1.661)	(-1.341)	(-4.638)	(-5.449)
Observations	363	363	349	292	292	292	349	349
Number of countries	104	104	100	74	74	74	100	100
AR2	0.890	0.820	0.930	0.950	0.978	0.943	0.840	0.891
Hansen	0.793	0.834	0.868	0.014	0.638	0.653	0.963	0.975
Number of instruments	96	96	103	68	63	71	108	116

This table shows the results of dynamic panel regressions for growth of real total per capita GDP using a GMM procedure following Arellano and Bover(1995). The explanatory variables are Turnover, the ratio of stock market value traded to GDP; Education, percentage of gross secondary school enrollment; Initial income, initial GDP per capita; and FDI expressed as a percentage of GDP. Some specifications also include interactions between private credit and a Low-Income Country (LIC) dummy variables and/or either the quality of bank bupervision, (from Abiad, et al, 2008) and the degree of trade openness (ratio of exports plus imports to GDP) . Data are averaged over non-overlapping five year periods beginning in 1980. Robust t-statistics are shown in parentheses, and significance at the 1 percent (***), 5 percent (**), and 10 percent (*) levels are indicated.

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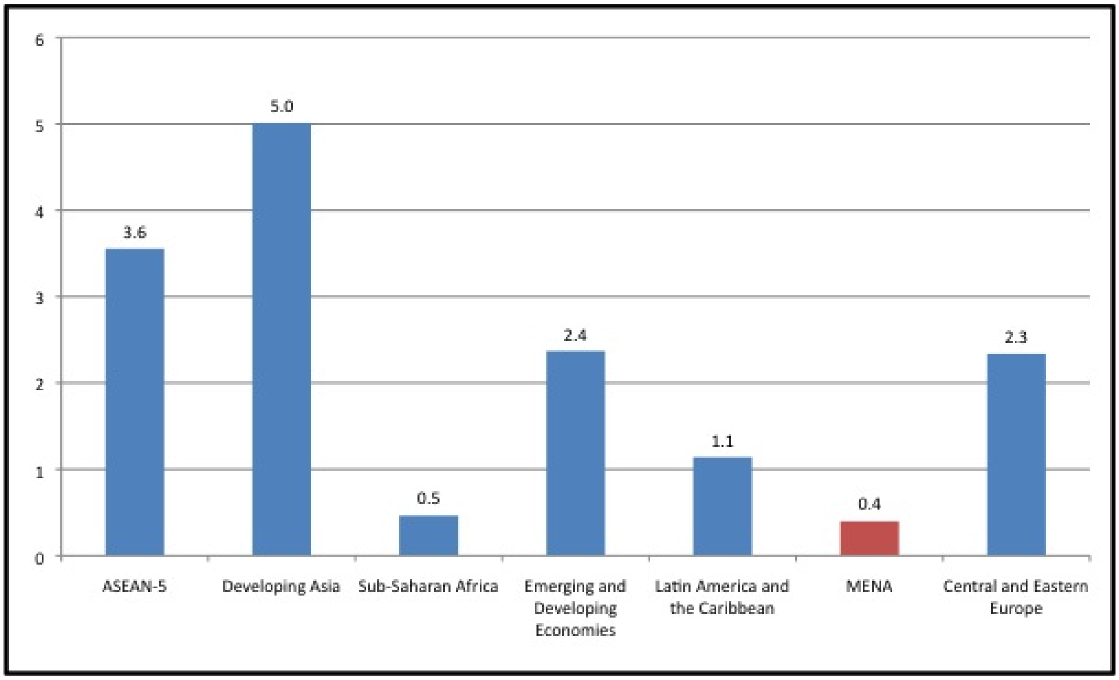

Figure 2.1: Average Annual Real Per Capita GDP Growth Rate 1975-2005 (percent)

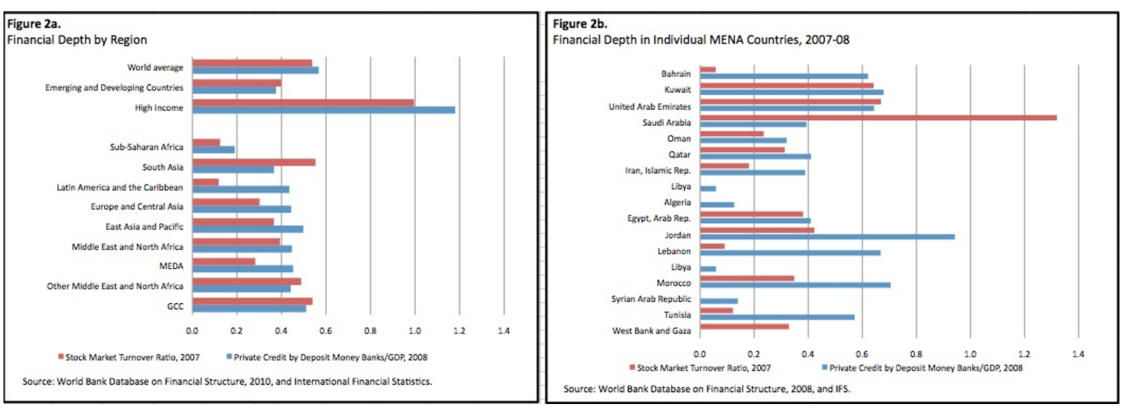

Figure 2.2: Financial Depth by Region and Countries

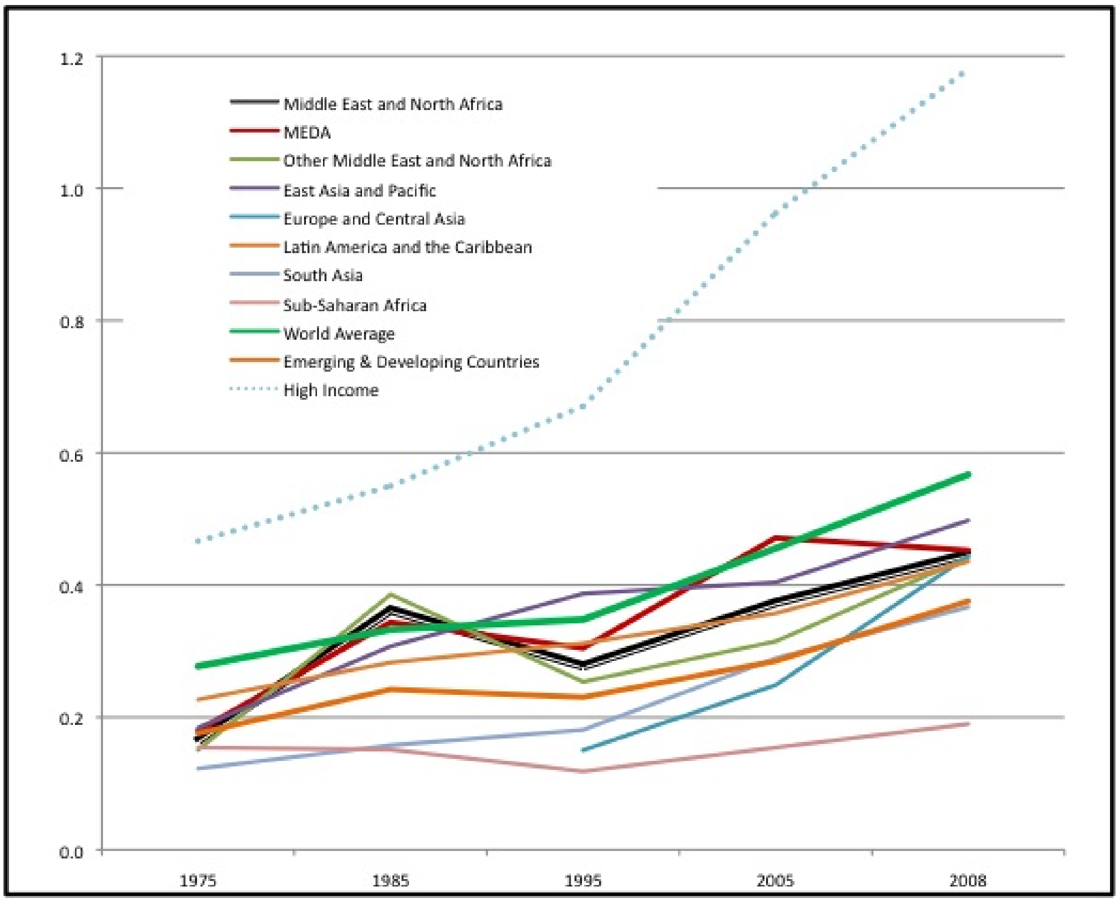

Figure 2.3: Deepening in the Banking Sector, Across Regions, 1975-2008

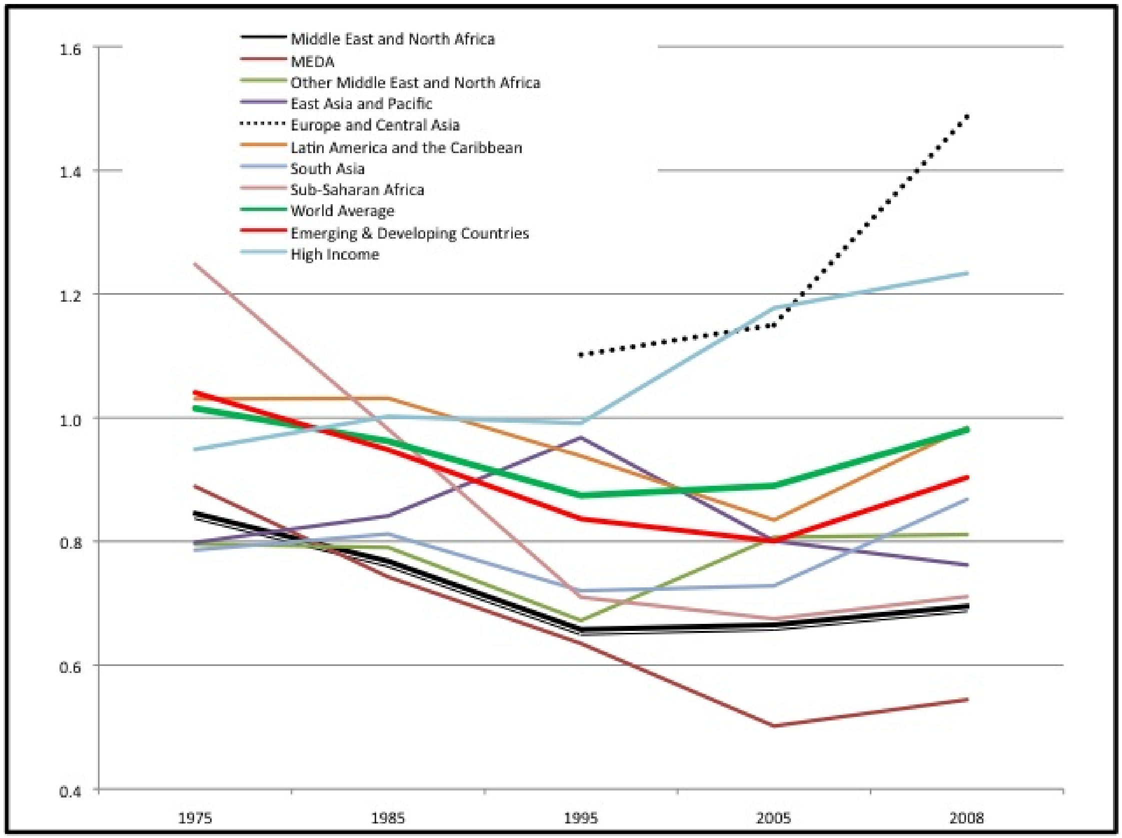

Figure 2.4: The Ratio of Private Credit to Deposits, 1975-2008

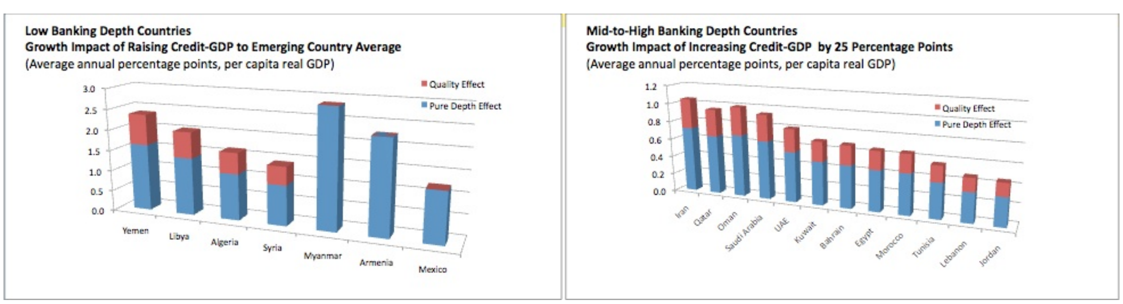

Figure 2.5: Estimated Impact of Increases in Credit-to-GDP on Real Per Capita Growth (Percentage Points)

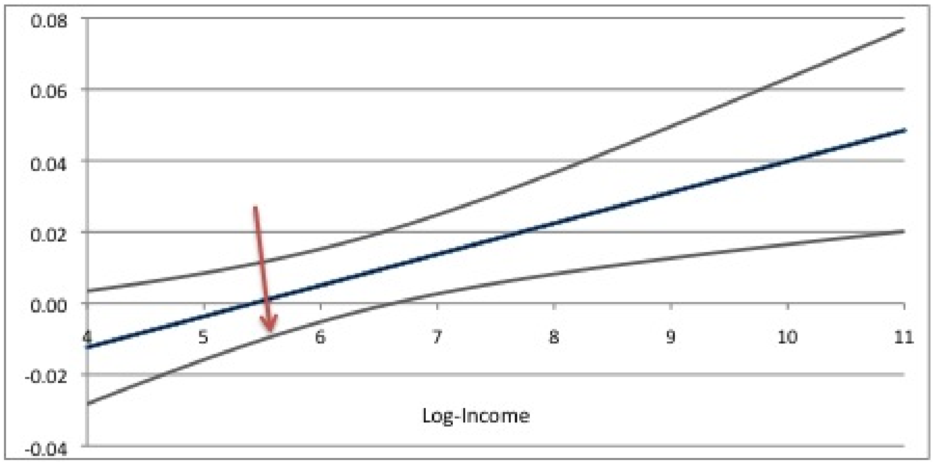

Figure 2.6: Estimated Marginal Impact of Increases in Private Credit-to-GDP on Growth at Different Income Levels (Percentage Points)

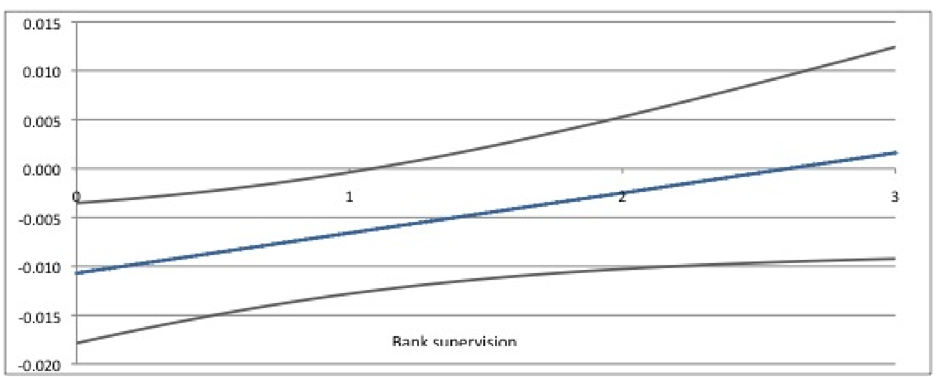

Figure 2.7: Estimated Differences between LICS and non-LICs in the Growth Impact of Private Credit at Different Levels of Bank Supervision Quality (Percentage Points)

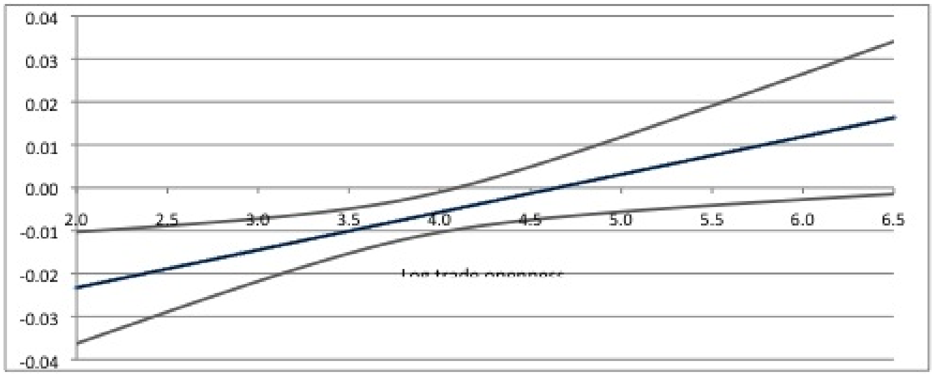

Figure 2.8: Estimated Differences between LICS and non-LICs in the Growth Impact of Private Credit at Different Levels of Trade Openness (Percentage Points)

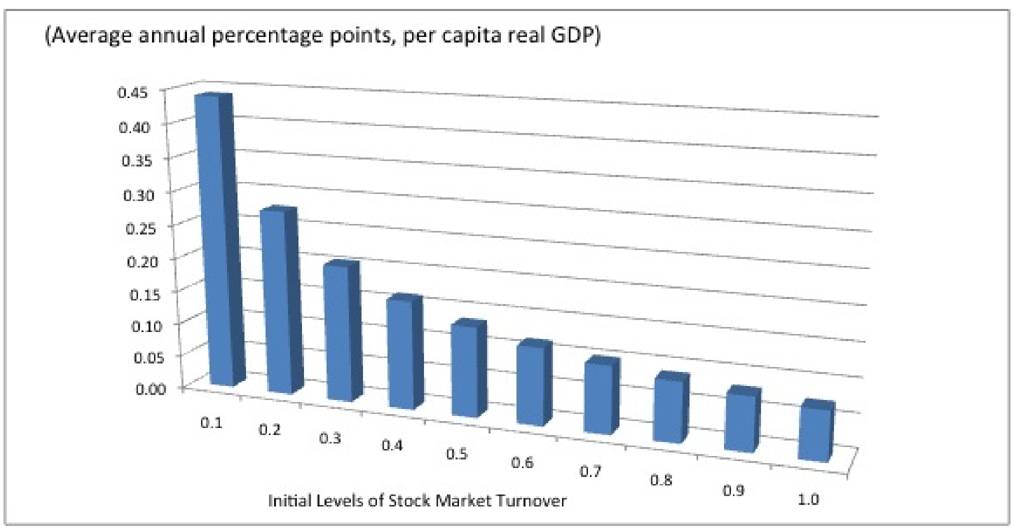

Figure 2.9: Estimated Increase in Long-Run Growth from an Increase in Stock Market Turnover by 20 Percentage Points of GDP, at Different Initial Levels of Turnover

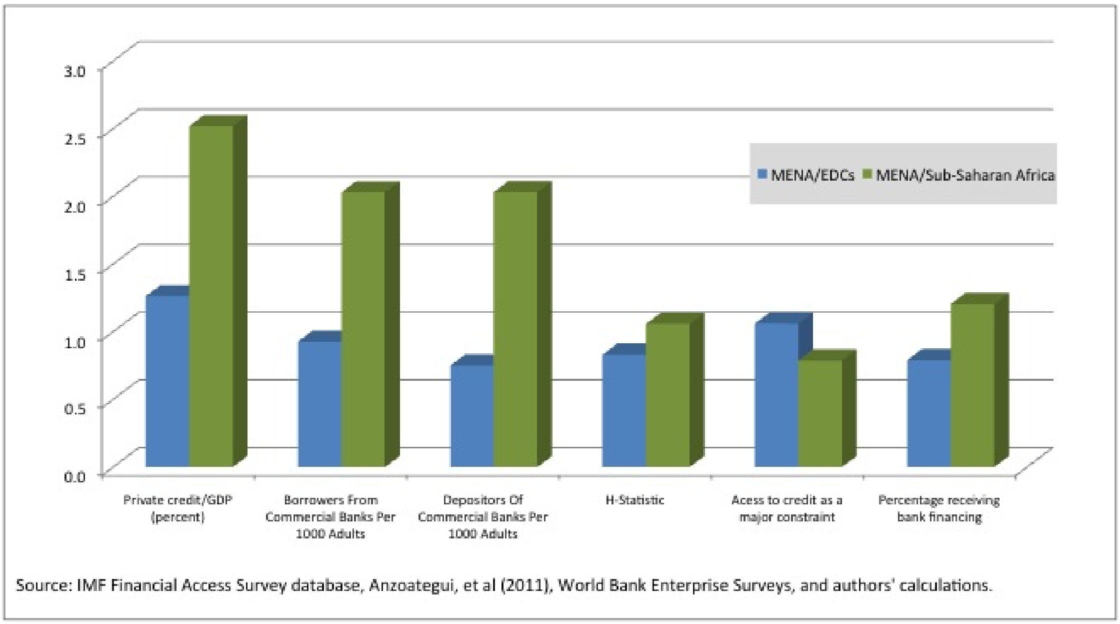

Figure 2.10: Banking Sector Performance in MENA Countries Relative to Emerging and Developing Country Average to Sub-Saharan Africa, 2008

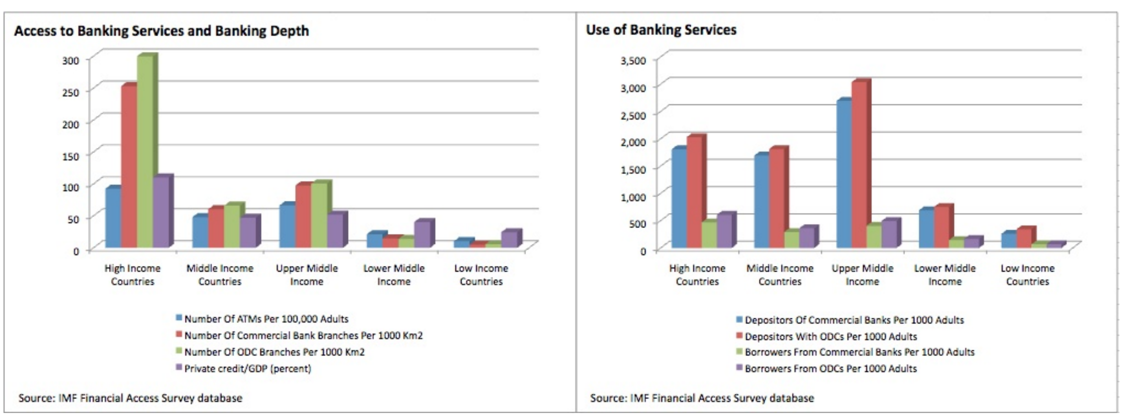

Figure 2.11: Financial Access, Use of Banking Services, and Depth across Income Groups, 2008

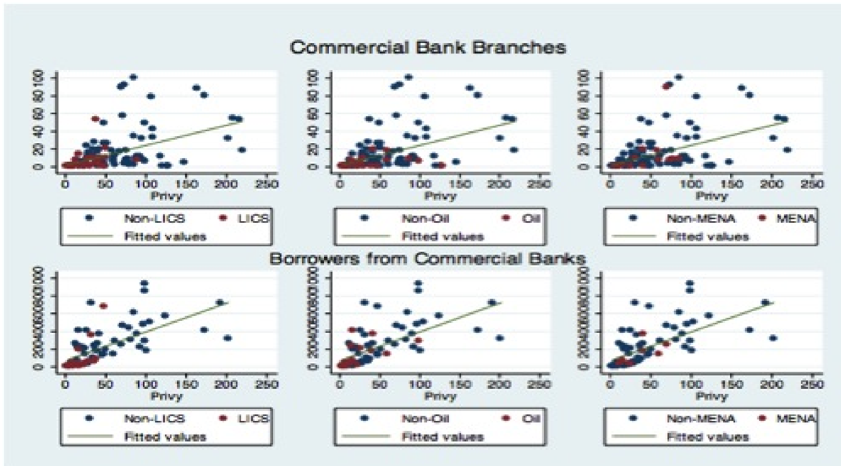

Figure 2.12: Financial Access and Banking Depth (Privy) across Countries

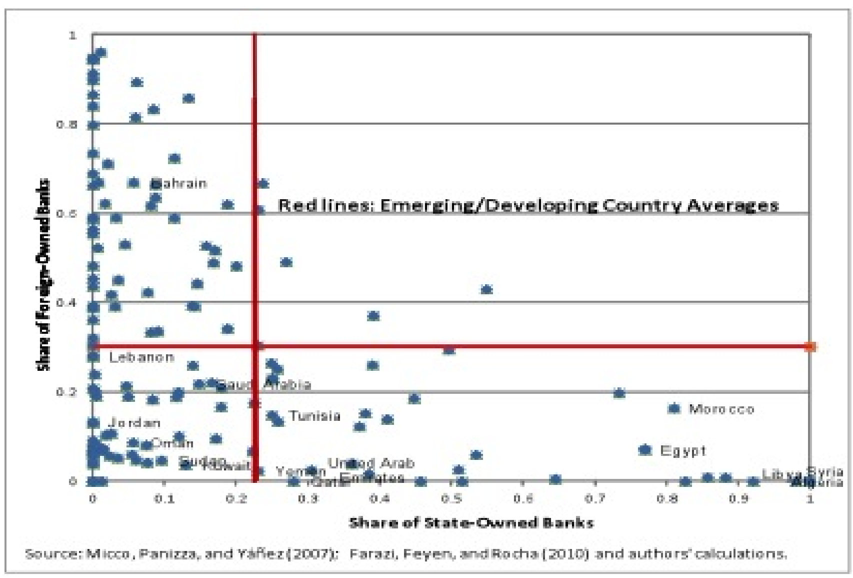

Figure 2.13: Share of Public and Foreign Banks throughout the World, 2002

Chapter 3

International Trade and Financial Crises: The Role of Credit Conditions

Exporting firms are among those affected the most during and after financial crises in countries. However, it is not vivid why contractions in exports are uneven among different industries. I investigate the impact of severe financial crises on industry level exports by exploiting the measures of financial vulnerability across sectors. I use five digit SITC exports of United Nations Commodity Trade (UN-Comtrade) database for 27 manufacturing industries in 15 countries hit by severe financial crises during the period 1975 - 2005. The data is then combined with sector-specific measures of asset tangibility and dependence on external finance to carry out the difference-in-difference and dynamic panel estimations. This paper adds to the literature in three ways. First, it provides a theoretical framework to provide insight on why sectors are hit disproportionately during and in the aftermath of severe financial distresses. The findings suggest that industries with greater reliance on outside financing and fewer shares of tangible assets experience greater contractions in export volumes in the years following a severe financial crisis. Second, it comprises empirical estimations that support the theoretical conclusions and confirm that the results are more robust for the industries with relatively higher reliance on outside funding and fewer tangible assets. Furthermore, it exhibits support for the complementarity between private credit by deposit money banks and asset tangibility in relation to the volume of exports.

3.1 Introduction

Research has shown that exporting sectors are significantly affected during and after financial crises. Based on the study by Chor and Manova (2012), the decline in world trade in the last quarter of 2009 was approximately 12% after the global financial crisis. That contraction exceeds twice the average loss in GDP in the same period, around 5.4%. Such dramatic collapses in exports following financial crises are usually associated with different factors including negative shocks in supply. However, it is not vivid why contractions in exports are uneven among different industries. It is also interesting to find out to what extent they are related to supply shocks such as greater restrictions in access to outside funding, as well as how different industries' exports are influenced by tighter credit conditions.

Bernard and Jensen (1999, 2004) argue that exporting establishments are on average more productive than domestic operating firms. However, they could potentially be affected more acutely by a financial distress due to the presence of fixed costs necessary to enter foreign markets. Furthermore, the impact might be adverse due to the existence of heterogeneity in financial vulnerabilities across sectors. Such observations raise questions about the impact of tighter credit constraints on exports in industries, and the ways by which those sectors are affected in response to the constraints. Do sector-specific financial vulnerabilities act as channels between financial distresses and contractions in exports? Is it possible to disentangle the channels through which these factors affect exports? With these questions in mind, this paper focuses on fifteen severe and relatively well known financial crises since World War II[1]. The series of financial distresses are presented in Table 3.1. Five incidences pertain to cases from advanced economies, which are considered to be more severe and systemic by Reinhart and Reinhart (2010), and the other ten episodes belong to emerging economies with midlevel incomes. In order to investigate the cross-industry contractions in exports during and in the years following the mentioned series of financial crises, five digit SITC level data on worldwide exports are employed in this study. The data, as explained in Section 3.3, is obtained from the depository of UN-Comtrade database.

Rajan and Zingales (1998) employed the difference-in-difference econometric methodology for the first time to illustrate that industries with higher reliance on external financing benefit more when a country develops its financial system. Using a similar approach, Fisman and Love (2003) showed that sectors which are more dependent on trade finance tend to grow at a faster pace. Similarly, Braun (2003) found evidence that the growth rate is faster in sectors with higher shares of tangible assets. Other studies such as Beck (2002, 2003) and Manova (2008) argued that sectors which are highly depen-

[1]Financial crises episodes are derived from Reinhart and Reinhart (2010) which include fifteen post-second World War scenarios of severe financial distresses between 1975 and 2005.

dent on outside financing have greater shares of exports in more financially developed countries. The latter study attributes its findings to the lower levels of search costs for intermediaries in developed economies. Manova (2008) also found that at low levels of financial development, industries with more tangible assets tend to export more. Concerns related to the endogeneity and reverse causality of empirical regressions are reduced by using the difference-in-difference approach in the above mentioned literature. However, this study employs the dynamic panel methodology, a frequently used method in the growth and finance literature as in Beck, Levine and Loayza (2000), to obtain more reliable estimates from the efficiency and consistency perspectives. In the following empirical exercises, the uneven impact of financial crises on industry exports are captured by the multiplication of a measure of financial vulnerability with a dummy indicating the years after a financial distress.

To the author's knowledge, Chor and Manova (2012) and Iacovone and Zavacka (2009) are the only studies that investigated the effects of banking and the recent global financial crises on industry-level exports. However, these papers suffer from few drawbacks in the view of this paper. First, none of the studies supports its empirical findings with a theoretical framework. Second, this paper's theoretical model along with its empirical exercises agree that shares of industry-specific asset tangibility are not significant channels between financial crises and exports unless explored under a certain condition. More specifically, exports in particular industries show greater and statistically more significant resilience to the negative macroeconomic shocks during financial crises. Those sectors are the industries that need to borrow relatively larger than the amount they have in terms of tangible assets. Third, this paper shows that private credit by deposit money banks[2] and shares of tangible assets are complementary to each other forming the volume of exports. Furthermore, this paper argues that the results are valid only for the severe financial crisis episodes. In other words, the results are statistically insignificant for the set of all banking crisis episodes used in the latter study by Iacovone and Zavacka (2009). One may note that this paper exploits the dynamic panel methodology to eliminate the concerns pertaining to the biases and inefficiencies potentially caused by the presence of reverse causality, omitted variables and endogeneity of the covariates. Also, different control variables, such as growth in terms of trade and lagged volume of exports, are employed in the regressions for robustness checks[3].

Some other less relevant papers have focused on the effects of macro-level shocks on exports. Borensztein and Panizza (2006) found that during sovereign defaults, industries with higher tendencies to export, acquire higher losses. Another study by Berman (2009) argued that currency devaluation has an ambiguous effect on exports during the periods of currency crises.

[2]For the purpose of this paper, *private credit* is used interchangeably with *private credit by deposit money banks*

[3]Another drawback of Iacovone and Zavacka (2009) is that the convergence effect for industry-level exports growth is captured by lagged shares of industries in total exports of the home country. Such a measure is problematic since industry-level exports and total exports in a country might be contracted simultaneously. Hence, the variable they used could not be a proper measure to capture the convergence impact - an effect that implies industries with larger exports grow at slower paces.

The contributions of the present study are of three folds. First, it provides a theoretical framework based on Manova (2013) to provide insights on the fact that industries are hurt adversely in the aftermath of a financial crisis depending on their financial vulnerabilities. For instance, sectors with higher dependence on outside financing and fewer shares of tangible assets are contracted disproportionately and to a greater extent. The model also predicts that the same effects are more significant for the sectors with greater reliance on outside financing along with those having fewer tangible assets such as land, property and equipment. Second, theoretical findings are confirmed by empirical estimations using the difference-in-difference and dynamic panel methodologies. However, the results do not generally apply for any set of banking crisis scenarios, as for the set of incidences of banking crises used in Iacovone and Zavacka (2009). Finally, there is strong empirical support for the complementarity between private credit by deposit money banks and asset tangibility of industries in the exports.

The organization of this paper is as follows: Section 3.2 provides a theoretical model to show that sector-specific credit conditions are the channels through which crises affect exports. Section 3.3 provides a description of the datasets devoted to this study. Section 3.4 illustrates the econometric methodologies and confirms theoretical findings with empirical results. Finally, Section 3.5 concludes, provides policy implications and outlines questions for future research.

3.2 Theoretical Model

This paper employs a theoretical model similar to that used by Manova (2013) who incorporated credit conditions of firms in a Melitz (2003) international trade framework. The current conducted study is different in the sense that it investigates sector-specific effects of financial crises and the decrease in repayment probability of investment on exports rather than those in the cases of financial liberalizations or declines in contract enforceability.

Households have utilities over their consumption of different varieties of goods in multi-sector environments. Utility is formulated as a Cobb-Douglas function over sector-specific consumption with a Constant Elasticity of Substitution (CES) equal to $\epsilon > 1$. The maximization problem of a representative household can be represented as:

$$Maximizing \qquad U_j = \Pi_i C_{ij}^{\delta_i},$$

where share of each industry in total expenditure is δ_i, and C_{ij} represents the aggregate industry-specific consumption over all possible varieties, w, in country j and industry i:

$$subject\ to \qquad C_{ij} = [\int_{\omega \in \Omega_{ij}} q_{ij}(\omega)^{\frac{\epsilon-1}{\epsilon}} d\omega]^{\frac{\epsilon}{\epsilon-1}}.$$

$q_{ij}(\omega)$ denotes quantity of consumption for each variety and the set of available varieties is represented by Ω_{ij}. Representing total expenditure on all goods (or income) in country j by I_j, the demand for each variety of sector i

in country j takes the traditional form of:

$$q_{ij}(\omega) = \frac{p_{ij}(\omega)^{-\epsilon}\delta_i I_j}{P_{ij}^{1-\epsilon}},$$

$$where \qquad P_{ij} = \left[\int_{\omega\in\Omega_{ij}} p_{ij}(\omega)^{1-\epsilon} d\omega\right]^{\frac{1}{1-\epsilon}},$$

and $p_{ij}(\omega)$ is the price of variety w in country j, and P_{ij} is the price index of industry i in the same country.

A static framework is assumed in which firms should pay a fixed cost of entry $c_{ij}f_{ej}$ before learning their productivity levels. c_{ij} is interpreted as the cost of a cost-minimizing input, which is specific to the industry and country of origin. The productivity level of a firm is denoted by $\frac{1}{\theta}$, where θ is drawn independently from a cumulative distribution $F(\theta)$ with a strictly positive support $[\theta_L\ \theta_H]$ which is the same across all countries. However, due to the differences in marginal costs of production, it costs a firm $c_{ij}\theta$ to produce one unit. Similar to Manova (2013), it is supposed that a fraction $t_i \in (0,1)$ of the entry costs are spent on collateralizable assets such as land, equipment and property. Braun (2003) argued that this fraction is inherent to the nature of industry and he called it the measure of *asset tangibility.*

For simplicity, it is assumed that once a firm enters the market and finds out its productivity level, there is no fixed cost of production for domestic market. This is due to the assumption that cash flows from operations fulfill the financing of domestic activities. However, a firm incurs a cost equal to $c_{ij}f_{jk}$ and iceberg cost of shipping, τ_{jk} to export from home country j to country k. f_{jj} is normalized to zero and f_{jk} is strictly positive for any country-pair. Although one may assume that variable costs are financed internally, firms need to borrow a proportion d_i of their fixed costs of exports by raising capital from outside funding. This fraction will be referred to as the degree of *external financial dependence* throughout the paper.

In an ideally reliable financial system, all investors may expect that all contracts would be fully repaid. However, depending on the financial stability which could be hit by a financial crisis and the degree of dependence on outside financing, a creditor in country j expects that the contract in industry i will be paid with probability $1-\rho_{ij}$. Otherwise, on average, a firm is expected to default with the probability ρ_{ij} in which the investor claims the collateral $t_i c_{ij} f_{ej}$. ρ_{ij} is considered to be exogenous to the model and increasing in reliance on outside financing. For example, it is more probable that a firm in an industry highly dependent on external financing incurs greater decline in the stock market, and thus higher liabilities.

Denoting repayment by $H(\theta)$, as a take-it-or-leave-it offer, the profit maximization problem of a firm can be written as:

$$\begin{aligned}
max_{p,q,H(\theta)} \quad & \pi_{ijk}(\theta) = p_{ijk}(\theta)q_{ijk}(\theta) - q_{ijk}(\theta)\tau_{jk}c_{ij}\theta - (1-d_i)\,c_{ij}f_{jk} \\
& \qquad -(1-\rho_{ij})H(\theta) - \rho_{ij}t_i c_{ij} f_{ej} \\
\text{subject to} \quad & (1) q_{ij}(\theta) = \tfrac{p_{ij}(\theta)^{-\epsilon}\delta_i I_j}{P_{jk}^{1-\epsilon}} \\
& (2) p_{ijk}(\theta)q_{ijk}(\theta) - q_{ijk}(\theta)\tau_{jk}c_{ij}\theta - (1-d_i)c_{ij}f_{jk} \geq H(\theta) \\
& (3) - d_i c_{ij} f_{jk} + (1-\rho_{ij})H(\theta) + \rho_{ij}t_i c_{ij} f_{ej} \geq 0,
\end{aligned}$$

where the left hand side of (2) is the maximum amount a firm with type θ can offer to an investor and (3) is the participation constraint for a creditor with zero outside option. In a competitive investment market, one might assume that the latter constraint is binding. Furthermore, it is straightforward to see that there is a productivity cutoff, $\frac{1}{\theta^*}$, for which the second constraint is binding; firms with productivity levels greater than the cutoff attain sufficient credit to operate in the exports market, while others with less productivity levels become financially constrained, although probably profitable in the exports market. Therefore, solving the constraints for the cutoff productivity level, one might obtain an implicit function as:

$$\epsilon\{(1-d_i+\frac{d_i}{(1-\rho_{ij})})c_{ij}f_{jk}-\frac{\rho_{ij}}{1-\rho_{ij}}t_ic_{ij}f_{ej}\}-(\frac{\tau_{jk}c_{ij}\theta^*_{ijk}}{\alpha P_{ij}})^{1-\epsilon}\delta_i I_j=0. \quad (3.1)$$

Plugging the binding constraints into the profit function, it is straightforward to show that successful exporters gain positive profits, i.e., profits are positive for exporters with productivity levels greater than $\frac{1}{\theta^*}$ if:

$$d_i f_{jk} > t_i f_{ej}. \quad (3.2)$$

The above condition states that credit conditions affect export decisions of firms when they need to borrow relatively larger than the amount they have in terms of tangible assets. This intuitive condition is confirmed with the empirical results in Section 3.4. One might obtain comparative statics based on the implicit function 3.1 to study uneven and cross-industry effects of financial crises. Those effects are due to increases in liabilities and probabilities of default:

$$\frac{\partial(1/\theta^*_{ijk})}{\partial\rho_{ij}} \propto -\frac{\epsilon(t_i c_{ij} f_{ej} - d_i c_{ij} f_{jk})}{\rho^2_{ij}} > 0. \tag{3.3}$$

The comparative static above indicates that in case of crisis and the consequent decline in the probability of repayment in an industry, productivity cutoff for participation increases. Hence, some firms exit the exports market, which leads to a decrease in total exports. In addition, in industries with higher dependence on outside funding or lower shares of tangible assets, productivity cutoff level is higher for the firms. In other words, in such industries, credit conditions are tougher for the firms to restore confidence among the customers - as expressed by the following comparative statics:

$$\tfrac{\partial(1/\theta^*_{ijk})}{\partial d_i} \propto \tfrac{\epsilon\rho_{ij}}{1-\rho_{ij}} c_{ij} f_{jk} > 0, \quad \tfrac{\partial(1/\theta^*_{ijk})}{\partial t_i} \propto -\tfrac{\epsilon\rho_{ij}}{1-\rho_{ij}} c_{ij} f_{ej} < 0. \tag{3.4}$$

Furthermore, in the presence of credit conditions, one would test the disproportionate effect of a crisis on a sector's exports:

$$\tfrac{\partial^2(1/\theta^*_{ijk})}{\partial d_i \partial\rho_{ij}} \propto \tfrac{\epsilon}{\rho^2_{ij}} c_{ij} f_{jk} > 0 \quad \tfrac{\partial^2(1/\theta^*_{ijk})}{\partial t_i \partial\rho_{ij}} \propto -\tfrac{\epsilon}{\rho^2_{ij}} c_{ij} f_{ej} < 0. \tag{3.5}$$

The equations above contain intuitive implications. They suggest that a change in productivity cutoff is pronounced in industries with higher reliance on external financing and is mitigated in sectors with greater tangible assets. These theoretical findings are confirmed in Section 3.4 by empirical analyses.

3.3 Data

Four sources of data are employed in this study to perform empirical estimations. Fifteen episodes of severe post-World War II financial crises between the years 1975 and 2005 are extracted from Reinhart and Reinhart (2010). Table 3.1 includes the list of countries and the years each of which experienced a financial crisis. Five of those episodes pertain to the more severe and systemic crises in advanced economies, five belong to the asian financial crisis and the rest five incidences are related to midlevel income economies. Observations include a wide range of economies from lower income countries such as Indonesia to developed countries such as Norway.

The United Nations Commodity Trade Database, also known as UN-Comtrade, provides detailed and disaggregated exports data for over 140 countries in the world. Five digit SITC Rev. 2 data for worldwide exports are collected for the list of fifteen countries during the period 1970 - 2005. The SITC codes are converted to their corresponding ISIC Rev. 2 codes using Haveman's correspondence table[4]. The disaggregate data is available in the current dollar value and in free on board measures for every single commodity, and exports are aggregated to match the classification of the main exogenous variables, i.e., aggregate exports at the ISIC industry level.

Two measures of industry-specific financial vulnerabilities are used in this study to investigate the heterogenous effects of financial crises on exports

[4]http://www.macalester.edu/research/economics/page/haveman/trade.resources/Concordances

across industries . Braun (2003) provides measures of dependence on external financing and asset tangibility for the manufacturing sectors. He employs financial dependence, originally calculated by Rajan and Zingales (1998), which measures the share of capital expenditure of firms not financed by either internal funds or operations for a median publicly-listed US company using Compustat database. The other measure he used, which is also considered to be inherent to the nature of industry, is the median asset tangibility. This measure is calculated in terms of the share of hard assets in each industry, i.e., net property, equipment, land and plant over total assets. The description of industries with their corresponding ISIC codes and financial vulnerability measures are provided in Table 3.2. Furthermore, Table 3.3 indicates that there exists a small negative correlation between these two measures, i.e., the industries high in dependence on outside financing do not necessarily have lower shares of tangible assets.

Other control variables such as annual real per capita GDP of countries and their terms of trade in goods and services are obtained from the World Bank publicly available database. Furthermore, *private credit* is obtained from a World Bank research dataset by Beck and Demirguc-Kunt (2009). The latter measures the ratio of private credit by deposit money banks to GDP for worldwide countries and it is extracted from the IMF's International Financial Statistics (IFS) database.

3.4 Empirics

3.4.1 Empirical Strategies

This paper examines the effects of financial crises on exports' growth using two econometric methodologies. These methods enable us to investigate whether or not sectors with greater financial vulnerabilities are hurt more during and after a severe financial crisis. The first approach is the difference-in-difference econometric analysis. It was suggested by Rajan and Zingales (1998), and a few studies such as Manova (2008) have exploited it to identify sector-specific channels between financial crises and exports. The dynamic panel methodology is the second econometric method conducted in this study. It is a widely employed method in the growth and finance literature as in Beck, Levine and Loayza (2000) and Beck and Levine (2004) which tackle concerns with efficiency and consistency of estimates. The following two subsections provide a brief description of both methodologies.

3.4.1.1 Difference in Difference

The differential impact of financial crises across different industries is studied by considering a baseline difference-in-difference regression as:

$$\Delta X_{ijt} = \alpha X_{ij,t-1} + \beta Z_i Crisis_{jt} + Control_{ijt} + \lambda_t + \lambda_{ij} + \epsilon_{ijt}, \qquad (3.6)$$

where X_{ijt} denotes the total exports of industry i in country j at year t. Hence, ΔX_{ijt}, which serves as the dependent variable, is the growth in exports for the same sector-country-year pair[5]. Z_i is the time-invariant financial vulnerability of industry i described in Section 3.3. The measures defining the vulnerability are *external financial dependence* and *asset tangibility* which are considered inherent to the nature of industries based on Braun (2003). The time-frame studied for each country extends between from three years before the date of financial crisis to three years after[6]. $Crisis_{jt}$ is an indicator for country j which is equal to one for the years after a financial crisis in that country, and zero otherwise. $Control_{ijt}$ is the set of control variables used in the regressions for the purpose of robustness checks. It varies from having no control variables to including terms of trade in goods and services, real GDP per capita and private credit by deposit money banks. To control for the convergence effect, lagged value of exports in the same country and industry is also included. One might expect α to be negative indicating that industries with larger exports tend to grow at slower pace. Other independent variables including λ_t and λ_{ij} are the fixed effects which control for long term growth trends of industry-country pairs. Furthermore, the error term of the regression is denoted by ϵ_{ijt}.

The main variable of interest is the interaction of financial vulnerability, either financial dependence or asset tangibility, with the crisis dummy. Finding a statistically significant estimate of β would confirm the existence of channels

[5]To exclude the outliers, exports with values less than 10 thousand dollars are dropped from the panel. Also, exports are included in the regressions in natural logarithm terms.

[6]The time window is also checked for 2 years and 4 years for the purpose of robustness check, both of which resulted in similar findings.

through industry-specific tighter credit conditions affecting the exports during and after a severe financial crisis. Furthermore, a negative coefficient means that during a crisis, an industry with greater financial vulnerability is affected more and experiences greater decline in exports. On the other hand, a positive β implies that more vulnerable sectors are more resilient to crisis shocks.

One might run the following regression as a substitute for equation 3.6 in which the dependent variable is the volume of exports rather than the growth of exports for the same industry-country pair:

$$X_{ijt} = (\alpha + 1)X_{ij,t-1} + \beta Z_i Crisis_{jt} + Control_{ijt} + \lambda_t + \lambda_{ij} + \epsilon_{ijt}. \qquad (3.7)$$

It is straightforward to see that unbiased estimates of equations 3.6 and 3.7 would result in the same coefficients for all covariates except for the convergence effect that would appear with a one unit difference.

3.4.1.2 The Dynamic Panel Methodology

The difference-in-difference methodology mitigates the biases caused by the endogeneity of dependent variables, and controls for omitted variables by the inclusion of fixed effects. However, to tackle the endogeneity and reverse causality issue, the present paper exploits the dynamic panel methodology. Financial crises might be influenced by the same causes or shocks that may affect exports performance. On the other hand, poor exports performance might trigger a financial crisis in a country. These concerns are resolved by using the system of method of moments in a dynamic panel framework.

All independent variables, excluding the strictly exogenous covariates, such as the fixed effects dummies, are assumed to be weakly exogenous (or predetermined). In other words, they are only affected by the present and past levels of exports growth and uncorrelated with future innovations. With this assumption, the two-step dynamic panel approach with Windmeijer (2005) standard error correction is used. This approach is a widely used econometric methodology in the finance and growth literature as in Aghion (2009). The method is proposed by Arellano and Bover (1995) and Blundell and Bond (1998), and it is based on an earlier method introduced by Arellano and Bond (1991). For empirical exercises with smaller time frames relative to the number of observations[7], the methodology combines two sets of moments to obtain unbiased and efficient estimates. One set is derived from the equation in levels and the other set from the equation in differences.

Equation 3.8 below is obtained by the first differencing Equation 3.6. It is clear that all time-invariant variables will be dropped in effect to differencing. As in the difference-in-difference method, this reduces the concerns related to the potential biases caused by omitted variables.

$$\Delta Growth(X_{ijt}) = \alpha \Delta X_{ij,t-1} + \beta Z_i \Delta Crisis_{jt} + \Delta Control_{ijt} + \Delta \lambda_t + \Delta \epsilon_{ijt}, \quad (3.8)$$

where $\Delta Y_{ijt} = Y_{ijt} - Y_{ij,t-1}$ for any variable Y. Although the endogeneity concerns related to omitted variables are not present in the above equation, the

[7]Roodman (2006) argues that if the number of time periods is not small relative to the number of observations, one should be concerned about the consistency of the estimates

new differenced equation introduces a new correlation between the difference of lagged exports, or $\Delta X_{ij,t-1}$, and the error term. Arellano and Bond (1991) obtain a set of moment conditions using the *weak exogeneity* assumption of the independent variables. Those predetermined variables are hence used as instruments for the differenced equation:

$$E[f_{ij,t-s}\Delta\epsilon_{ijt}] = 0 \qquad \forall t \geq 3, s = 2, \tag{3.9}$$

where f_{ijt} denotes the set of all endogenous and weakly exogenous variables including the lagged exports, as well as other control variables, such as real per capita GDP and lagged value of terms of trade.

The second set of moment conditions are obtained based on the original regression in levels (Equation 3.6). Assuming that lagged differences of the independent variables are uncorrelated with the error term, another set of moment conditions are obtained as:

$$E[\Delta f_{ij,t-s}(\lambda_{ij} + \epsilon_{ijt})] = 0 \qquad \forall t \geq 3, s = 2. \tag{3.10}$$

Stacking all the moments from the equations in levels and differences, a two-step GMM estimation is performed. Error terms are assumed to be independent and homoskedastic in the first step. At the end of the first stage, variance-covariance matrices are estimated, based on which another GMM estimation is performed. This process allows for the dependence and heteroskedasticity of error terms.

3.4.2 Empirical Results

3.4.2.1 Difference in Difference

The empirical results confirm the theoretical findings by statistically robust and significant estimates. External financial dependence is used as the measure of financial vulnerability in Table 3.5. Different combinations of the control variables are included in the regressions to check the robustness of the results[8]. Columns (4) - (6) also include the interaction of private credit and financial dependence, in addition to other control variables. The difference-in-difference regressions suggest that the main coefficient of interest, β, for the interaction of financial dependence and the crisis dummy, is negative and statistically significant. Therefore, exports in the sectors with higher reliance on external financing are affected more severely in the years following severe financial crises. The coefficient varies between -0.106 and -0.125 depending on the control variables used in the econometric model. The impact is outstanding and suggests that financial dependence is an important channel through which industries' exports are affected in the aftermath of financial crises. For instance, *Industrial Chemicals* sector has an external financial dependence which is less than the average of all industries. In this example, the least expected decrease in exports for an average manufacturer in that sector, implied by the smallest coefficient, -0.106, would be around 2.2% after a financial crisis in the home country. This example illustrates how significant the role of financial dependence could be as a channel between financial crises

[8]Standard errors are calculated by clustering countries and industries together.

and exports in industries. One might also notice that the coefficient β has an absolute value less than one in all the regressions. It is consistent with the econometric model based on both regressions 3.6 and 3.7. Based on the latter equation, $(\alpha+1)$ is the correlation between the lagged and the current volume of exports (measured in levels), a parameter expected to be positive. In other words, industries with greater volumes of exports tend to export more in the future.

Other control variables also present intuitive results with statistically significant coefficients. As expected, the coefficient α in Equation 3.6 is negative, which is an evidence for the widely accepted convergence effect. In other words, industries with greater levels of exports grow at a slower pace relative to the sectors with smaller exports volumes. Furthermore, the inclusion of lagged growth of terms of the trade in goods and services illustrates a negative impact of that variable on exports. This means that for a certain country, greater growth in terms of trade leads to lower growth rate in exports.

Although the empirical results exhibit that external financial dependence acts as a channel for the process by which financial crises affect exports, they do not show such strong impact for asset tangibility in general. Table 3.6 presents the results of the same regressions as in Table 3.5 with the difference that asset tangibility is used as the measure of financial vulnerability rather than the reliance on outside financing. The coefficients for the interaction of asset tangibility of industries and the crisis dummy are positive. However, the coefficients are diverse and statistically insignificant. Thus, greater shares in tangible assets do not necessarily translate into higher resilience towards the shocks by financial crises.

Although it seems that shares of tangible assets do not operate as significant channels through which a crisis may affect exports, the inclusion of their interaction with private credit leads to intriguing estimation results. According to the estimations reported in columns (4) - (6) of Table 3.6, strong and positive estimates of the coefficient suggest that as private credit increases in a country (relative to GDP of the same country), industries with greater asset tangibilities grow faster in the exports market. One might interpret this effect as an evidence for the existence of a kind of complementarity between private credit and collateralizable assets. In other words, greater access to private credit gives room to the firms to maintain their assets and grow in the exports market. Such an effect could be of interest to policy makers in deciding how to allocate private credit efficiently among sectors in the aftermath of a financial crisis. First, as mentioned in the Introduction, exports are usually hurt severely during a financial crisis. The decline in exports sometimes exceeds twice the size of decline in economic growth; therefore, instant policy actions should be made to save the exporting industries. Second, the ratio of private credit to GDP decreases during and after the years following a severe financial crisis, an evidence quantified by Reinhart and Reinhart (2010). Therefore, private credit, which serves as a determinant of growth[9], becomes

[9] It is a widely empirical concept that private credit by deposit money banks enhance growth. Examples are the seminal works by Beck and Levine (2004), Levine (2004) and Levine and Zervos (1998)

scarce and should be allocated more carefully.

3.4.2.2 Dynamic Panel

As expressed earlier in Section, the frequently used difference-in-difference methodology mitigates the biases caused by omitted variables and reverse causality. Therefore, to address the concerns related to the efficiency and consistency of the estimates, as well as the robustness of the results, this section provides the results of the dynamic panel methodology. The outcomes reported in Tables 3.7 and 3.8 exhibit implications similar to the ones presented by the difference-in-difference econometric model. Financial dependence is a channel through which a financial crisis may adversely hit industries, where there is no such a significant impact for the share of tangible assets. Likewise, exports in sectors highly relying on outside funding are more affected. However, magnitudes of impacts are slightly less relative to those obtained by the difference-in-difference methodology. Furthermore, the convergence effect is captured. It is also noticed that sectors in economies with higher growth rates in terms of trade experience lower growth rates in exports.

To quantify the heterogenous impact of a severe financial crisis on exports, one could calculate the cross sector difference of the impact based on the level of financial dependence of sectors. Take the Textile industry, with the mediocre level of 0.400, and the professional and scientific equipment sector, with a high level of financial dependence, 0.961. Based on the estimations in column (3) of Table 3.7, the differential impact of a crisis on the exports of these two industries would be 0.097 (obtained from $-0.111 \times \{log(0.961) - log(0.400)\}$). It implies that Textile firms would suffer %9.7 less contraction in exports than the industries pertaining professional and scientific equipment in the aftermath of a crisis.

One might wonder if similar impacts are detected for financial crisis episodes different from the fifteen scenarios used in the present study. Iacovone and Zackara (2009) identify 21 banking crisis episodes that occurred in the developed and developing countries between the period 1980-2000. This paper investigated the same experiments and applied the econometric estimations for the mentioned 21 banking crisis incidences. Unlike the results for the fifteen post-World War II financial crises, there was no statistically strong evidence that financial dependence or asset tangibility acts as a channel through which banking crises are linked to poor exports performance. The difference between the results by Iacovone and Zackara (2009) and those in this paper could be according to two main reasons. First, they use a series of banking crises while this paper uses incidences of severe financial crises. A non-severe banking crisis might not decrease the probability of repayment in investment as intensely as a severe financial crisis does. Furthermore, this paper uses UN-Comtrade data at a more disaggregated level (i.e., 5 digit rather than 4 digit SITC exports) which may considerably influence the significance and preciseness of the results.

3.4.2.3 Does Magnitude of Financial Vulnerability Matter?

The theoretical model suggests that under the condition by Equation 3.2, credit constraints play important roles in the firms' decision whether to operate in the exports market or not. A firm might be potentially profitable in the exports market but unable to do so because of the borrowing constraints. Therefore, one should expect that the comparative statics (illustrated by Equations 3.5) be more robust when the measures of financial vulnerabilities satisfy Equation 3.2. To test this hypothesis, this paper investigated the difference-in-difference and dynamic panel regressions for a particular sample of industries.. This particular sample is selected from the industries whose dependence on outside financing are greater than the mean (i.e., 0.253) and shares of tangible assets are higher than the average (i.e., 0.304)[10]. It is interesting to observe that for this sample of industries, asset tangibility works as a channel through which financial crises affect exports. Table 3.9 suggests that for such a sample (industries with relatively higher reliance on outside financing and fewer tangible assets), the greater the share of tangible assets, the more resilient the industry exports are to the negative shocks of financial crises. This finding is consistent with the theoretical model and exhibits statistically more significant estimates, an observation that is absent when using the whole sample of sectors.

[10]This method is employed due to the limitations in data, since neither of the fixed costs f_{ij} and f_{eji} could be estimated.

3.5 Conclusion

Although manufacturing sectors in a country operate in similar financial environments, they demonstrate different degrees of resilience towards financial distresses. Firms in some sectors experience dramatic declines during and in the aftermath of financial distresses, while those in other industries display less vulnerabilities. This study provides strong evidence that credit conditions play important roles in the way exporting establishments are affected in the aftermath of severe financial crises.

This paper focused on 15 episodes of severe post-World War II financial crises, and the uneven contractions in the exports of 27 manufacturing industries. The theoretical model along with two econometric methodologies, the difference-in-difference and the more precise dynamic panel regressions, identified channels through which a crisis could disproportionately affect exports.

Industries with higher reliance on outside funding experience greater contractions in exports in the years following a financial distress. Adversely, sectors with more tangible assets show more resilience to the negative shocks by tighter credit conditions. Intuitively, this is because such industries can use their land, equipment, plant, etc. as collaterals to attain funding. Moreover, the results imply that all these effects are more significant in industries with relatively greater financial dependence and fewer tangible assets. In addition, the fact that both indicators of credit conditions are uncorrelated makes the empirical results more intriguing since they capture different aspects of financial vulnerability.

Interestingly, credit conditions do not generically act as channels through which any crisis might affect export volumes. The results are not robust for the set of banking crises used by Iacovone and Zavacka (2009), although they prove to be important determinants of the impact of severe financial crises on exports (the episodes classified by Reinhart and Reinhart (2010)).

Finally, empirical findings provide evidence that asset tangibility and private credit are complementary to each other in shaping exports patterns. In other words, sectors with more tangible assets benefit to a greater extent in response to deeper financial developments (measured by the ratio of private credit by deposit money banks to the real GDP). Therefore, policy makers may use private credit as a tool to boost growth in exports in the industries with more tangible assets.

Policy makers should take into account the vulnerability of different sectors to increase the resilience of industries during financial crises. The significance is not only to safeguard industries against domestic financial distresses, but also to protect them from negative spillover effects of foreign slowdowns. Financial stresses spread rapidly among the economies and transmission channels are growing with the integration of the world financial markets. Considering characteristics of the exporting sectors, suitable policies should be employed to lower fragility in exports market. Long term policies may include structural reforms, such as increasing labor market mobility, in order to enable vulnerable companies cut their costs rapidly during busts. Other short term policies, such as directed lending, and providing social safety nets should also accompany proactive considerations in order to effectively support the exporting industries.

Table 3.1: Financial Crisis Episodes

Country	Type of Crisis	Year Of Crisis
Spain	Advanced	1977
Norway	Advanced	1987
Finland	Advanced	1991
Sweden	Advanced	1991
Japan	Advanced	1992
Indonesia	Asian	1997
Korea	Asian	1997
Malaysia	Asian	1997
Philippines	Asian	1997
Thailand	Asian	1997
Argentina	Other	2001
Chile	Other	1981
Colombia	Other	1998
Mexico	Other	1994
Turkey	Other	2001

Source: 15 episodes of severe post-World War II financial crises during 1975 - 2005, identified by Reinhart and Reinhart (2010).

Table 3.2: Industry Financial Vulnerability

ISIC	Industry	Fin.Dep.	Tang
311	Food products	0.137	0.378
313	Beverages	0.077	0.280
314	Tobacco	-0.451	0.221
321	Textiles	0.400	0.373
322	Wearing apparel, except footwear	0.029	0.132
323	Leather products	-0.140	0.091
331	Wood products, except furniture	0.284	0.380
332	Furniture, except metal	0.236	0.263
341	Paper and products	0.176	0.558
342	Printing and publishing	0.204	0.301
352	Other chemicals	0.219	0.197
353	Petroleum refineries	0.042	0.671
354	Misc. petroleum and coal products	0.334	0.304
355	Rubber products	0.227	0.379
356	Plastic products	1.140	0.345
361	Pottery, china, earthenware	-0.146	0.075
362	Glass and products	0.529	0.331
369	Other non-metallic products	0.062	0.420
371	Iron and steel	0.087	0.458
372	Non-ferrous metals	0.006	0.383
381	Fabricated metal products	0.237	0.281
382	Machinery, except electrical	0.445	0.183
383	Machinery, electric	0.768	0.213
384	Transport equipment	0.307	0.255
385	Prof and scient equipment	0.961	0.151
390	Other manufactured products	0.470	0.188
3511	Industrial chemicals	0.205	0.412

Notes: Based on Rajan and Zingales (1998), Fin.Dep. measures the share of capital expenditure of firms not financed by either internal funds or operations for a median publicly-listed US company. Tang is the median asset tangibility calculated as the share of hard assets in each industry, i.e., net property, equipment, land and plant over total assets.

Table 3.3: Correlations

	Fin.Dep.	Tang
Fin.Dep.	1	
Tang	-0.041	1

Notes: Based on Rajan and Zingales (1998), Fin.Dep. measures the share of capital expenditure of firms not financed by either internal funds or operations for a median publicly-listed US company. Tang is the median asset tangibility calculated as the share of hard assets in each industry, i.e., net property, equipment, land and plant over total assets.

Table 3.4: Summary Statistics

	Obs	Mean	Std. Dev.	Min	Max
Fin.Dep.	27	0.253	0.330	-0.451	1.140
Tang	27	0.304	0.137	0.075	0.671

Notes: Based on Rajan and Zingales (1998), Fin.Dep. measures the share of capital expenditure of firms not financed by either internal funds or operations for a median publicly-listed US company. Tang is the median asset tangibility calculated as the share of hard assets in each industry, i.e., net property, equipment, land and plant over total assets.

Table 3.5: Difference in Difference - Financial Dependence

	(1)	(2)	(3)	(4)	(5)	(6)
Lag. Exports	-0.047***	-0.047***	-0.049***	-0.047***	-0.046***	-0.048***
	(-4.730)	(-4.698)	(-4.477)	(-4.702)	(-4.675)	(-4.434)
Crisis X Fin.Dep.	-0.107**	-0.125***	-0.122**	-0.106**	-0.123***	-0.118**
	(-2.279)	(-2.665)	(-2.556)	(-2.243)	(-2.632)	(-2.490)
Fin.Dep. X Privy				-0.051	-0.044	-0.058
				(-1.202)	(-1.027)	(-1.263)
Constant	0.716***	7.254**	7.853**	0.730***	7.083**	7.532*
	(7.725)	(2.165)	(2.036)	(7.643)	(2.099)	(1.939)
Other Variables	FE	FE,GDP	TT,FE,GDP	FE	FE,GDP	TT,FE,GDP
Observations	1639	1639	1550	1639	1639	1550
Number of id	297	297	287	297	297	287

Notes: The dependent variable is the growth in exports (log difference of exports) which is obtained from the disaggregated UN-Comtrade 5 digit SITC data. Based on Rajan and Zingales (1998), Fin.Dep. measures the share of capital expenditure of firms not financed by either internal funds or operations for a median publicly-listed US company. Crisis is an indicator which is equal to one for the years following a financial crisis, and zero otherwise. Terms of Trade represents the lagged value of growth in terms of trade in goods and services in the home country, and Privy is the ratio of private credit by deposit money banks to GDP. The time-frame extends between three years before the date of financial crisis to three years after. All regressions include country, industry and year fixed effects as well as real per capita GDP of the home country. The regressions in columns (3) and (6) include terms of trade in goods and services, denoted by TT. Robust t-statistics are presented below the corresponding coefficients. Symbols ***, ** and * mean significance at 1%, 5% and 10%, respectively.

Table 3.6: Difference in Difference - Asset Tangibility

	(1)	(2)	(3)	(4)	(5)	(6)
Lag. Exports	-0.047***	-0.047***	-0.050***	-0.050***	-0.049***	-0.051***
	(-4.726)	(-4.677)	(-4.522)	(-4.815)	(-4.771)	(-4.548)
Crisis X Tang	0.084	0.044	0.121	0.077	0.030	0.109
	(0.697)	(0.342)	(0.903)	(0.654)	(0.240)	(0.828)
Tang X Privy				0.387***	0.400***	0.392***
				(3.559)	(3.758)	(3.490)
Constant	0.659***	5.651	5.536	0.263*	6.096*	5.775
	(7.28)	(1.573)	(1.35)	(1.904)	(1.688)	(1.405)
Other Variables	FE	FE,GDP	TT,FE, GDP	FE	FE,GDP	TT,FE,GDP
Observations	1639	1639	1550	1639	1639	1550
Number of id	297	297	287	297	297	287

Notes: The dependent variable is the growth in exports (log difference of exports) which is obtained from the disaggregated UN-Comtrade 5 digit SITC data. Tang is the median asset tangibility calculated as the share of hard assets in each industry, i.e., net property, equipment, land and plant over total assets. Crisis is an indicator which is equal to one for the years following a financial crisis, and zero otherwise. Terms of Trade represents the lagged value of growth in terms of trade in goods and services in the home country, and Privy is the ratio of private credit by deposit money banks to GDP. The time-frame extends between three years before the date of financial crisis to three years after. All regressions include country, industry and year fixed effects as well as real per capita GDP of the home country. The regressions in columns (3) and (6) include terms of trade in goods and services, denoted by TT. Robust t-statistics are presented below the corresponding coefficients. Symbols ***, ** and * mean significance at 1%, 5% and 10%, respectively.

Table 3.7: Dynamic Panel - Financial Dependence

	(1)	(2)	(3)	(4)	(5)	(6)
Lag. Exports	-0.119***	-0.066***	-0.064***	-0.048**	-0.068***	-0.061***
	(-3.153)	(-3.696)	(-4.054)	(-2.494)	(-3.744)	(-3.211)
Crisis X Fin.Dep.	-0.082	-0.113**	-0.111**	-0.099*	-0.107**	-0.113**
	(-1.415)	(-1.977)	(-1.977)	(-1.959)	(-2.008)	(-2.062)
Fin.Dep. X Privy				-0.067	0.102	0.031
				(-0.958)	(1.564)	(0.385)
Constant	0.897***	-1.386***	-0.783**	0.352**	-1.169***	-0.696**
	(3.083)	(-3.894)	(-2.578)	(2.408)	(-3.402)	(-2.246)
Other Variables	FE	FE,GDP	TT,FE,GDP	FE	FE,GDP	TT,FE,GDP
Observations	1639	1639	1550	1639	1639	1550
Number of id	297	297	287	297	297	287
AR2	0.735	0.711	0.778	0.72	0.71	0.788
Hansen	0.000123	0.295	0.782	0.0136	0.59	0.96
Instruments	121	222	256	169	247	283

Notes: The dependent variable is the growth in exports (log difference of exports) which is obtained from the disaggregated UN-Comtrade 5 digit SITC data. Based on Rajan and Zingales (1998), Fin.Dep. measures the share of capital expenditure of firms not financed by either internal funds or operations for a median publicly-listed US company. Crisis is an indicator which is equal to one for the years following a financial crisis, and zero otherwise. Terms of Trade represents the lagged value of growth in terms of trade in goods and services in the home country, and Privy is the ratio of private credit by deposit money banks to GDP. The time-frame extends between three years before the date of financial crisis to three years after. All regressions include country, industry and year fixed effects as well as real per capita GDP of the home country. The regressions in columns (3) and (6) include terms of trade in goods and services, denoted by TT. Robust t-statistics are presented below the corresponding coefficients. Symbols ***, ** and * mean significance at 1%, 5% and 10%, respectively.

Table 3.8: Dynamic Panel - Asset Tangibility

	(1)	(2)	(3)	(4)	(5)	(6)
Lag. Exports	-0.124***	-0.068***	-0.066***	-0.045**	-0.079***	-0.072***
	(-3.295)	(-3.764)	(-4.145)	(-2.292)	(-4.583)	(-3.514)
Crisis X Tang	0.180	0.194	0.212	0.195	0.192	0.215
	(0.900)	(1.063)	(1.123)	(1.055)	(1.072)	(1.161)
Tang X Privy				-0.041	0.259**	0.181
				(-0.393)	(2.533)	(1.436)
Constant	0.891***	-1.415***	-0.851***	0.304*	-1.111***	-0.784**
	(3.054)	(-4.017)	(-2.669)	(1.906)	(-3.118)	(-2.198)
Other Variables	FE	FE,GDP	TT,FE,GDP	FE	FE,GDP	TT,FE,GDP
Observations	1639	1639	1550	1639	1639	1550
Number of id	297	297	287	297	297	287
AR2	0.69	0.67	0.732	0.676	0.698	0.773
Hansen	7.58E-05	0.309	0.751	0.0103	0.608	0.962
Instruments	121	222	256	169	247	283

Notes: The dependent variable is the growth in exports (log difference of exports) which is obtained from the disaggregated UN-Comtrade 5 digit SITC data. Tang is the median asset tangibility calculated as the share of hard assets in each industry, i.e., net property, equipment, land and plant over total assets. Crisis is an indicator which is equal to one for the years following a financial crisis, and zero otherwise. Terms of Trade represents the lagged value of growth in terms of trade in goods and services in the home country, and Privy is the ratio of private credit by deposit money banks to GDP. The time-frame extends between three years before the date of financial crisis to three years after. All regressions include country, industry and year fixed effects as well as real per capita GDP of the home country. The regressions in columns (3) and (6) include terms of trade in goods and services, denoted by TT. Robust t-statistics are presented below the corresponding coefficients. Symbols ***, ** and * mean significance at 1%, 5% and 10%, respectively.

Table 3.9: Do Magnitudes of Financial Vulnerabilities Matter?

	(1)	(2)	(3)	(4)	(5)	(6)
Lag. Exports	-0.013	-0.024	-0.008	-0.024	-0.033	-0.011
	(-0.236)	(-0.579)	(-0.204)	(-0.635)	(-0.949)	(-0.279)
Crisis X Tang	1.798**	1.782**	2.111***	1.711**	1.768**	2.057***
	(2.438)	(2.332)	(2.934)	(2.444)	(2.523)	(2.968)
Tang X Privy				0.396	0.328	0.100
				(1.095)	(0.756)	(0.187)
Constant	-0.007	1.490	1.812	0.142	1.507	2.009*
	(-0.012)	(1.130)	(1.501)	(0.318)	(1.143)	(1.778)
Other Variables	FE	FE,GDP	TT,FE,GDP	FE	FE,GDP	TT,FE,GDP
Observations	417	417	393	417	417	393
Number of id	72	72	70	72	72	70
AR2	0.594	0.598	0.596	0.607	0.599	0.606
Hansen	0.273	0.302	0.362	0.155	0.228	0.397
Instruments	52	54	56	54	56	58

Notes: The dependent variable is the growth in exports (log difference of exports) which is obtained from the disaggregated UN-Comtrade 5 digit SITC data. Tang is the median asset tangibility calculated as the share of hard assets in each industry, i.e., net property, equipment, land and plant over total assets. Crisis is an indicator which is equal to one for the years following a financial crisis, and zero otherwise. Terms of Trade represents the lagged value of growth in terms of trade in goods and services in the home country, and Privy is the ratio of private credit by deposit money banks to GDP. The time-frame extends between three years before the date of financial crisis to three years after. All regressions include country, industry and year fixed effects as well as real per capita GDP of the home country. The regressions in columns (3) and (6) include terms of trade in goods and services, denoted by TT. Robust t-statistics are presented below the corresponding coefficients. Symbols ***, ** and * mean significance at 1%, 5% and 10%, respectively.

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